Private University of Tacna (UPT)

Faculty of Architecture and Urban Planning

School of Architecture



Curricular Plan 2027

– Reporte Final–

Última modificación: 2026

This document is based on the international proposal of ACM/IEEE-CS *Computing Curricula*, which also served as the basis for the Spanish version created by the Peruvian Computer Society (SPC).

ISBN:

Task Force

Executive Summary

This document presents the curricular design of the Arquitectura program at Universidad Privada de Tacna (UPT) under international standards and the global references of the *Body of Knowledge of Architecture*. It synthesizes the disciplinary evolution of Arquitectura, from its design and building fundamentals to the demands of resilient, sustainable and smart cities in the 21st century. The program adapts these global references to our regional context:

- Local and national requirements for housing, urban development and heritage conservation.
- Institutional strengths in applied research, innovation in materials, construction methods and project management.
- Emerging trends in digitalization, building automation and sustainability in Arquitectura.

Contemporary Arquitectura integrates the following domains:

- Architectural Design and History, Theory and Criticism
- Core Technical Areas (Building Technology and Construction, Structural Systems, Environmental Systems, Urban Design and Planning)
- Modern Trends (Digital Representation and BIM, Sustainability, Heritage Conservation, Real Estate Development)
- Soft Skills and Professional Ethics.

The pedagogical model rests on four pillars:

- **Design excellence**: Architectural design studios, structural systems, building technology and construction.
- **Digital innovation**: BIM modeling, emerging representation technologies and efficient project management.
- **Comprehensive sustainability**: Circular economy, resilient design, environmental impact and responsible resource management.
- **Integral human formation**: Virtues, ethical awareness, public responsibility and professional social commitment.

Universidad Privada de Tacna (UPT), true to its identity, incorporates formation as a pillar, developing in students:

- The ability to discern the ethical and social impact of design and technical decisions.
- Sensitivity to challenges of equity, public safety and community development through the built environment.
- Commitment to integral human development and the common good, especially for vulnerable populations.
- Values-based leadership, professional integrity and service to society.

This curriculum will produce professionals with:

- The ability to conceive, design and oversee the construction of buildings and urban spaces that are safe, functional, sustainable and economically viable.
- Competencies to lead digital transformation in architectural projects using advanced methodologies and tools.
- The ability to integrate design excellence with environmental sustainability, social responsibility and disaster resilience.
- A formation that allows them to practice their profession with design excellence, moral integrity and a sense of public service.

The proposal incorporates mechanisms for continuous updating, ensuring relevance in the face of technological evolution and alignment with international standards, while preserving the distinctive character of Universidad Privada de Tacna (UPT)'s formation.

Contents

Acknowledgments **xxi**

Abreviaturas **xxiii**

1 Introducción **1**
1.1 Legal framework . . . 2
1.1.1 General legal framework . . . 2
1.1.2 Institutional regulatory framework . . . 2
1.2 Conclusions of the curricular plan review . . . 2
1.2.1 Justification of the program . . . 2
1.2.2 Program supply and demand . . . 2
1.2.3 Problems facing the profession . . . 3
1.2.4 State of the art . . . 3
1.2.5 Similar experiences . . . 4
1.3 Basic definitions . . . 4
1.4 Admission profile . . . 5
1.5 Program objectives . . . 5
1.6 Graduate profile . . . 5
1.6.1 Career Outcomes . . . 5
1.6.2 Learning Outcomes . . . 6
1.6.3 Graduate profile . . . 7
1.6.4 Professional Profile . . . 7
1.7 Resources to teach . . . 8
1.8 Document Organization . . . 8

2 Curricula 2027 **9**
2.1 Course Coding . . . 9
2.2 Curricular Structure . . . 10
2.3 Topics distributed by course . . . 14
2.3.1 General Architecture topics/course . . . 14
2.3.2 Architectural Sciences topics/course . . . 20
2.3.3 Urbanism topics/course . . . 22
2.3.4 Project Management topics/course . . . 24
2.4 Expected outcomes distributed by course . . . 25
2.5 Courses by Outcome . . . 30
2.5.1 Outcome: AG-A01) Evaluates the impact of architecture. . . . 30
2.5.2 Outcome: AG-A02) Applies ethics and respect for diversity. . . . 30
2.5.3 Outcome: AG-A03) Works effectively in multidisciplinary teams. . . . 30
2.5.4 Outcome: AG-A04) Communicates effectively through reports and presentations. 30
2.5.5 Outcome: AG-A05) Manages projects with economic judgment. . . . 30
2.5.6 Outcome: AG-A06) Learns continuously and adapts to new technology. . . . 31
2.5.7 Outcome: AG-A07) Applies science and technology to architectural solutions. . 31
2.5.8 Outcome: AG-A08) Understands structural and environmental design problems. 31
2.5.9 Outcome: AG-A09) Creates aesthetic and technically sound designs. . . . 31
2.5.10 Outcome: AG-A10) Conducts studies using research methods. . . . 32

2.5.11 Outcome: AG-A11) Designs buildings for environmental comfort. 32
2.5.12 Outcome: AG-A12) Designs within cost and regulatory constraints. 32
2.5.13 Outcome: AG-A13) Designs with ecological and environmental responsibility. . 32
2.5.14 Outcome: AG-A14) Applies creativity in construction techniques. 32
2.5.15 Outcome: AG-A15) Understands the relationship between people, buildings, and environment. 32
2.6 Course distribution in the Career 33
2.7 Departments 35
2.7.1 BasicSciences 35
2.7.2 DCB 36
2.8 Compatibility of the Career with International Standards 36
2.9 Teaching guidelines 37
2.10 Evaluation system 37

3 Detailed content by course 41
First Semester 41
AR1B1 Introduction to BIM (Mandatory) 41
AR1D1 Design Studio I (Mandatory) 45
AR1R1 Geometry and Analog Drawing (Mandatory) 49
MA100 Basic Mathematics (Mandatory) 52
MA111 Calculus I (Mandatory) 54
EG163 Communication I (Mandatory) 56
EG164 Digital Competencies Development (Mandatory) 59
EG165 Strategies for Autonomous Learning (Mandatory) 62
EG166 Basic Mathematics (Mandatory) 65
Second Semester 68
AR1B2 Parametric Modeling and Generative Design (Mandatory) 68
AR1D2 Design Studio II (Mandatory) 72
AR2R1 Digital Drafting (Mandatory) 77
ID101 Technical and professional English I (Mandatory) 80
EG263 Communication II (Mandatory) 83
EG264 Philosophy (Mandatory) 86
EG265 Peruvian Territory. National Defense and Security (Mandatory) 89
Third Semester 92
AR1D3 Design Studio III (Mandatory) 92
AR2B1 Multidisciplinary Coordination (Mandatory) 96
AR3R1 3D Modeling and Virtual Animation (Mandatory) 99
ID102 Technical and professional English II (Mandatory) 103
EG364 Ethics (Mandatory) 107
EG366 Personal Development and Leadership (Mandatory) 110
Fourth Semester 113
AR1T1 Digital Topography (Mandatory) 113
AR2B2 BIM Execution Planning (Mandatory) 116
AR2D1 Design Studio IV (Mandatory) 119
ID201 Technical and professional English III (Mandatory) 123
EG363 Ecology and Sustainable Development (Mandatory) 127
EG365 Peru's Problems and Challenges in a Global World (Mandatory) 130
Fifth Semester 133
AR2B3 BIM Scheduling and Cost (Mandatory) 133
AR2D2 Design Studio V (Mandatory) 136
ID202 Technical and professional English IV (Mandatory) 141
Sixth Semester 145
AR2D3 Design Studio VI (Mandatory) 145
AR3B1 Structural and MEP Coordination (Mandatory) 149
ID203 Technical and professional English V (Mandatory) 152
Seventh Semester 156

AR3B2 Sustainability and Circular Economy (Mandatory) . . . 156
AR3D1 Design Studio VII (Mandatory) . . . 159
AR400 Scientific Research Methodology (Mandatory) . . . 163
Eighth Semester . . . 167
AR3B3 Facilities Management (Mandatory) . . . 167
AR3D2 Design Studio VIII (Mandatory) . . . 170
AR401 Statistics and Research Instruments (Mandatory) . . . 174
Ninth Semester . . . 178
AR3B4 Heritage and Infrastructure (Mandatory) . . . 178
AR3D3 Design Studio IX (Mandatory) . . . 182
AR402 Research Workshop (Mandatory) . . . 186
Tenth Semester . . . 189
AR3D4 Design Studio X (Mandatory) . . . 189
AR403 Research Work (Mandatory) . . . 194
AR404 Innovation and Entrepreneurship (Mandatory) . . . 196
AR4B1 AI-Assisted Automation (Mandatory) . . . 199

4 Professors & Courses 203
Taught courses by professor . . . 203
Professor assigned per course . . . 203

5 Equivalences with Other Curriculum Plans 207

6 Laboratories 209

A Body of knowledge of General Architecture 211
A.1 Architectural Design (ADG) . . . 212
A.1.1 ADG/Foundations of Architectural Design (Core Tier1: 1 hr, Core Tier2: 1 hr) 213
A.1.2 ADG/Visual and Plastic Arts Foundations (Core Tier1: 1 hr, Core Tier2: 1 hr) 213
A.1.3 ADG/Design Process and Creative Methods (Core Tier1: 1 hr, Core Tier2: 1 hr) 214
A.1.4 ADG/Performance-Driven Design (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 215
A.1.5 ADG/Human-Centered and Inclusive Design (Core Tier1: 1 hr, Core Tier2: 1 hr) 215
A.1.6 ADG/Gender-Sensitive and Trauma-Informed Design . . . 216
A.1.7 ADG/Computational and Generative Design (Core Tier1: 1 hr, Core Tier2: 1 hr) 216
A.1.8 ADG/Tropical and Bioclimatic Design (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 217
A.1.9 ADG/Large-Scale and Complex Buildings . . . 217
A.1.10 ADG/Design Research Methods . . . 218
A.2 History, Theory and Criticism (HTA) . . . 218
A.2.1 HTA/World Architecture: Antiquity to the Middle Ages (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 218
A.2.2 HTA/Evolution of Peruvian Architecture (Core Tier1: 1 hr, Core Tier2: 1 hr) 219
A.2.3 HTA/Modernism and the International Style (Core Tier1: 1 hr, Core Tier2: 1 hr) 220
A.2.4 HTA/Latin American Architectural Traditions (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 220
A.2.5 HTA/Contemporary Architecture and Global Trends (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 221
A.2.6 HTA/Architectural Theory and Criticism (Core Tier1: 1 hr, Core Tier2: 1 hr) 221
A.2.7 HTA/Decolonial and Postcolonial Perspectives (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 222
A.2.8 HTA/Vernacular and Indigenous Architecture . . . 222
A.2.9 HTA/Futures Studies and Speculative Architectures . . . 223
A.3 Building Technology and Construction (BTC) . . . 223
A.3.1 BTC/Building Systems and Assemblies (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 224
A.3.2 BTC/Facade and Building Envelope Technology (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 224
A.3.3 BTC/Conventional Construction Materials (Core Tier1: 1 hr, Core Tier2: 1 hr) 225
A.3.4 BTC/Biobased and Mycelium Materials (Core Tier1: 1 hr, Core Tier2: 1 hr) . 225

A.3.5 BTC/Circular and Recycled Materials (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 226
A.3.6 BTC/Smart and Responsive Materials (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 226
A.3.7 BTC/Digital Fabrication and CNC Manufacturing (Core Tier1: 1 hr, Core Tier2: 1 hr) 227
A.3.8 BTC/Robotic and Automated Construction 227
A.4 Structural Systems for Architecture (STR) 228
A.4.1 STR/Structural Principles and Mechanics (Core Tier1: 1 hr, Core Tier2: 1 hr) 228
A.4.2 STR/Vertical Load Path and Foundations (Core Tier1: 1 hr, Core Tier2: 1 hr) 229
A.4.3 STR/Residential and Vernacular Structural Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) 229
A.4.4 STR/Lateral Load-Resisting Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 230
A.4.5 STR/Long-Span and Special Structures (Core Tier1: 1 hr, Core Tier2: 1 hr) . 230
A.4.6 STR/Structural Morphology and Form-Finding (Core Tier1: 1 hr, Core Tier2: 1 hr) 231
A.4.7 STR/Computational Structural Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr) . 231
A.4.8 STR/Foundation and Geotechnical Considerations (Core Tier1: 1 hr, Core Tier2: 1 hr) 232
A.4.9 STR/Seismic Design for Architecture (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 232
A.4.10 STR/AI-Assisted Structural Optimization 233
A.5 Environmental Systems and Sustainability (ENV) 233
A.5.1 ENV/Daylighting and Visual Comfort (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 233
A.5.2 ENV/Thermal Comfort and Passive Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) 234
A.5.3 ENV/Natural Ventilation and Indoor Air Quality (Core Tier1: 1 hr, Core Tier2: 1 hr) 234
A.5.4 ENV/Mechanical Systems (HVAC) (Core Tier1: 1 hr, Core Tier2: 1 hr) 235
A.5.5 ENV/Building Automation and Smart Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) 235
A.5.6 ENV/Acoustics and Noise Control (Core Tier1: 1 hr, Core Tier2: 1 hr) 236
A.5.7 ENV/Energy Efficiency and Net-Zero Design (Core Tier1: 1 hr, Core Tier2: 1 hr) 236
A.5.8 ENV/Water, Sanitation, and Waste Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) 237
A.5.9 ENV/Regenerative and Circular Design (Core Tier1: 1 hr, Core Tier2: 1 hr) . 237
A.5.10 ENV/Climate Resilience and Adaptation 238
A.6 Urban Design and Planning (UDP) 238
A.6.1 UDP/Urban Form and Morphology (Core Tier1: 1 hr, Core Tier2: 1 hr) 239
A.6.2 UDP/Historical Urban Planning Theories (Core Tier1: 1 hr, Core Tier2: 1 hr) 239
A.6.3 UDP/Contemporary Planning Methods and Theory (Core Tier1: 1 hr, Core Tier2: 1 hr) 239
A.6.4 UDP/Urban Design at Multiple Scales (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 240
A.6.5 UDP/Housing and Residential Environments (Core Tier1: 1 hr, Core Tier2: 1 hr) 240
A.6.6 UDP/Informal Settlements and Incremental Urbanization (Core Tier1: 1 hr, Core Tier2: 1 hr) 241
A.6.7 UDP/Urban Data Science and GeoAI (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 241
A.6.8 UDP/Smart Cities and Urban Digital Twins 242
A.6.9 UDP/Landscape and Open Space Design (Core Tier1: 1 hr, Core Tier2: 1 hr) 242
A.6.10 UDP/Social Equity and Inclusive Urbanism (Core Tier1: 1 hr, Core Tier2: 1 hr) 243
A.7 Professional Practice and Ethics (PRO) 243
A.7.1 PRO/Architecture as a Profession (Core Tier1: 1 hr, Core Tier2: 1 hr) 243
A.7.2 PRO/Project Delivery Methods and Contracts (Core Tier1: 1 hr, Core Tier2: 1 hr) 244
A.7.3 PRO/Project Management and Construction Economics (Core Tier1: 1 hr, Core Tier2: 1 hr) 244
A.7.4 PRO/Collaborative and Interdisciplinary Practice (Core Tier1: 1 hr, Core Tier2: 1 hr) 245
A.7.5 PRO/Ethics, Decolonial Practice, and Social Responsibility (Core Tier1: 1 hr, Core Tier2: 1 hr) 245
A.7.6 PRO/Business of Architecture and Entrepreneurship 246

A.7.7 PRO/Future of the Profession: AI and New Roles . . . 246
A.8 Architectural Representation and Digital Tools (REP) . . . 247
A.8.1 REP/Orthographic Drawing and Conventions (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 247
A.8.2 REP/Computer-Aided Drafting (CAD) (Core Tier1: 1 hr, Core Tier2: 1 hr) . 248
A.8.3 REP/Graphic Symbols and Drafting Conventions (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 248
A.8.4 REP/Three-Dimensional Modeling (Core Tier1: 1 hr, Core Tier2: 1 hr) 249
A.8.5 REP/Architectural Communication and Presentation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 249
A.8.6 REP/Parametric Design and Visual Programming (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 250
A.8.7 REP/Simulation and Performance Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr) 250
A.8.8 REP/Augmented, Virtual, and Mixed Reality (XR) . . . 251
A.8.9 REP/Generative AI for Architectural Design (Core Tier1: 1 hr, Core Tier2: 1 hr)251
A.8.10 REP/Digital Fabrication Output and CNC Toolpaths . . . 252
A.9 Interior Architecture and Space Design (INT) . . . 252
A.9.1 INT/Interior Space Planning and Programming (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 253
A.9.2 INT/Materials, Finishes, and Specifications (Core Tier1: 1 hr, Core Tier2: 1 hr) 253
A.9.3 INT/Furniture, Equipment, and Ergonomics (Core Tier1: 1 hr, Core Tier2: 1 hr)254
A.9.4 INT/Lighting Design (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 254
A.9.5 INT/Acoustics in Interior Spaces (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 254
A.9.6 INT/Universal Design and Accessibility (Core Tier1: 1 hr, Core Tier2: 1 hr) . 255
A.9.7 INT/Healthcare and Specialized Interiors . . . 255
A.9.8 INT/Sustainable Interior Design . . . 256
A.10 Heritage Conservation and Restoration (HER) . . . 256
A.10.1 HER/Theory and Philosophy of Conservation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 257
A.10.2 HER/Historic Documentation and Digital Survey (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 257
A.10.3 HER/Structural Assessment of Historic Buildings (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 258
A.10.4 HER/Restoration and Consolidation Techniques (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 258
A.10.5 HER/Adaptive Reuse and Building Transformation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 259
A.10.6 HER/Landscape and Urban Heritage . . . 259
A.10.7 HER/Intangible Heritage and Living Traditions . . . 260
A.11 Landscape Architecture (LAN) . . . 260
A.11.1 LAN/Landscape Design Principles and Process (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 261
A.11.2 LAN/Plants, Ecology, and Ecosystem Services (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 261
A.11.3 LAN/Landform, Hydrology, and Grading (Core Tier1: 1 hr, Core Tier2: 1 hr) 262
A.11.4 LAN/Landscape Materials and Construction (Core Tier1: 1 hr, Core Tier2: 1 hr)262
A.11.5 LAN/Urban Landscape and Green Infrastructure (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 263
A.11.6 LAN/Climate-Responsive Landscape Design (Core Tier1: 1 hr, Core Tier2: 1 hr)263
A.11.7 LAN/Ecological Restoration and Nature-Based Solutions . . . 264
A.11.8 LAN/Landscape at Regional and Territorial Scale . . . 264
A.12 Real Estate Development and Construction Economics (RED) . . . 264
A.12.1 RED/Real Estate Market Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr) 265
A.12.2 RED/Development Process and Feasibility (Core Tier1: 1 hr, Core Tier2: 1 hr) 265
A.12.3 RED/Construction Cost Estimation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 266
A.12.4 RED/Project Finance and Investment (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 266

A.12.5 RED/Housing Policy and Affordable Development . . . 267
A.12.6 RED/Circular Economy and Adaptive Reuse Economics . . . 267
A.12.7 RED/Stakeholder and Participatory Development . . . 268
A.12.8 RED/PropTech and Digital Real Estate Innovation . . . 268
A.13 Research Methods and Emerging Technologies (RES) . . . 269
A.13.1 RES/Research Design and Methodologies (Core Tier1: 1 hr, Core Tier2: 1 hr) 269
A.13.2 RES/Quantitative Methods in Architectural Research (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 269
A.13.3 RES/Qualitative and Ethnographic Methods (Core Tier1: 1 hr, Core Tier2: 1 hr) 270
A.13.4 RES/Evidence-Based Design (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 270
A.13.5 RES/Neuroscience and Cognitive Approaches . . . 271
A.13.6 RES/AI and Machine Learning in Architectural Research (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 271
A.13.7 RES/Speculative and Future-Oriented Research . . . 272
A.13.8 RES/IoT, Sensing, and Smart Building Research . . . 272
A.13.9 RES/Post-Occupancy Evaluation and Building Science (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 273
A.13.10 RES/Theoretical Framework and Literature Review (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 273
A.13.11 RES/Research Hypotheses and Variables (Core Tier1: 1 hr, Core Tier2: 1 hr) . 274
A.14 Architectural Regulations and Standards (NRM) . . . 274
A.14.1 NRM/Building Codes, Accessibility, and Zoning (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 275
A.14.2 NRM/Peruvian Regulatory Framework for Architectural Practice (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 275
A.15 Building Information Modeling (BIM) . . . 276
A.15.1 BIM/BIM Fundamentals and Authoring (Core Tier1: 1 hr, Core Tier2: 1 hr) . 277
A.15.2 BIM/Parametric Modeling and Visual Scripting for BIM (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 277
A.15.3 BIM/Multidisciplinary Model Coordination (Core Tier1: 1 hr, Core Tier2: 1 hr) 278
A.15.4 BIM/4D BIM and Construction Scheduling (Core Tier1: 1 hr, Core Tier2: 1 hr) 278
A.15.5 BIM/5D BIM and Cost Estimation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 278
A.15.6 BIM/BIM for Structural and MEP Coordination (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 279
A.15.7 BIM/BIM for Sustainability Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 279
A.15.8 BIM/BIM for Facilities Management (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 279
A.15.9 BIM/BIM Execution Planning and Standards (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 280
A.15.10 BIM/Collaborative BIM Workflows (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 280
A.15.11 BIM/Heritage BIM (HBIM) (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 280
A.15.12 BIM/BIM for Infrastructure and Urban Modeling (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 281
A.15.13 BIM/AI-Assisted BIM Automation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 281
A.15.14 BIM/BIM Standards, Policy, and Contracts (Core Tier1: 1 hr, Core Tier2: 1 hr) 282
A.15.15 BIM/BIM-Based Construction Documentation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 282
A.15.16 BIM/BIM Model Organization and Worksharing (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 283
A.15.17 BIM/Generative Design and Optioneering (Core Tier1: 1 hr, Core Tier2: 1 hr) 283
A.15.18 BIM/Model-Based Issue and RFI Management (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 283
A.15.19 BIM/BIM Across Project Delivery Methods (Core Tier1: 1 hr, Core Tier2: 1 hr) 284
A.15.20 BIM/Lean Construction and 4D BIM Integration (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 284
A.15.21 BIM/Fabrication-Level BIM Detailing (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 285

A.15.22 BIM/BIM Model Quality Control and Auditing (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 285
A.15.23 BIM/BIM for Circular Economy and Material Reuse (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 285
A.15.24 BIM/BIM-Supported Green Building Certification (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 286
A.15.25 BIM/Operational Digital Twins from BIM (Core Tier1: 1 hr, Core Tier2: 1 hr) 286
A.15.26 BIM/Asset Classification and Data Standards for FM (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 287
A.15.27 BIM/Reality Capture for BIM: Point Clouds and Photogrammetry (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 287
A.15.28 BIM/Integrated BIM Project Delivery (Capstone) (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 287
A.15.29 BIM/Emerging Trends in BIM Practice . . . 288
A.15.30 BIM/BIM Software Practicum (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 288

B Body of knowledge of Architectural Sciences 289
B.1 Calculus and Analysis (CAN) . . . 289
B.1.1 CAN/Limits and Continuity (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 290
B.1.2 CAN/Differential Calculus (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 290
B.1.3 CAN/Integral Calculus (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 290
B.1.4 CAN/Improper Integrals (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 290
B.1.5 CAN/Sequences, Series, and Power Series (Core Tier1: 1 hr, Core Tier2: 1 hr) 291
B.1.6 CAN/Applications of the Definite Integral (Core Tier1: 1 hr, Core Tier2: 1 hr) 291
B.1.7 CAN/Vectors and the Geometry of Space (Core Tier1: 1 hr, Core Tier2: 1 hr) 291
B.1.8 CAN/Quadric Surfaces (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 291
B.1.9 CAN/Parametric Equations and Polar Coordinates (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 292
B.1.10 CAN/Multivariable and Vector Calculus (Core Tier1: 1 hr, Core Tier2: 1 hr) . 292
B.2 Algebra and Number Theory (ANT) . . . 292
B.2.1 ANT/Matrices and Systems of Linear Equations (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 293
B.2.2 ANT/Vector Spaces and Linear Transformations (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 293
B.3 Geometry and Topology (GTO) . . . 293
B.3.1 GTO/Euclidean and Projective Geometry (Core Tier1: 1 hr, Core Tier2: 1 hr) 293
B.3.2 GTO/Differential Geometry of Curves and Surfaces (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 294
B.4 Classical Mechanics (CME) . . . 294
B.4.1 CME/Kinematics and Dynamics of Particles (Core Tier1: 1 hr, Core Tier2: 1 hr) 294
B.4.2 CME/Rotational Motion and Angular Momentum (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 295
B.4.3 CME/Elasticity (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 295
B.4.4 CME/Fluids: Hydrostatics, Hydrodynamics, and Viscosity (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 296
B.4.5 CME/Vibrations and Waves (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 296
B.4.6 CME/Transport Phenomena (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 297
B.5 Probability Theory (PRO) . . . 297
B.5.1 PRO/Probability Axioms and Properties (Core Tier1: 1 hr, Core Tier2: 1 hr) . 297
B.5.2 PRO/Conditional Probability and Independence (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 298
B.5.3 PRO/Discrete Random Variables and Distributions (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 298
B.5.4 PRO/Continuous Random Variables and Distributions (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 298
B.5.5 PRO/Limit Theorems: LLN and CLT (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 299

B.6 Descriptive Statistics and Data Analysis (DSC) . . . 299
B.6.1 DSC/Numerical Summaries: Location, Spread, and Shape (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 299
B.7 Statistical Inference (INF) . . . 300
B.7.1 INF/Point Estimation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 300
B.7.2 INF/Interval Estimation and Confidence Intervals (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 300
B.7.3 INF/Hypothesis Testing Foundations (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 300
B.8 Regression and Statistical Models (REG) . . . 301
B.8.1 REG/Simple Linear Regression (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 301

C Body of knowledge of Urbanism 303
C.1 Foundations of the City and Urbanization (UFD) . . . 304
C.1.1 UFD/The City, Urbanization, and Urban Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 304
C.1.2 UFD/History and Theories of Urbanism (Core Tier1: 1 hr, Core Tier2: 1 hr) . 305
C.1.3 UFD/Urbanization in Latin America (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 305
C.1.4 UFD/Peruvian and Andean Urbanism (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 306
C.1.5 UFD/Urban Form and Morphology (Core Tier1: 1 hr, Core Tier2: 1 hr) 306
C.1.6 UFD/Culture, Identity, and Urban Landscape (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 306
C.1.7 UFD/Informality and the Social Production of the City (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 307
C.1.8 UFD/Contemporary Theories and Urban Futures (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 307
C.2 Territorial Analysis and Urban Information Systems (TAN) . . . 308
C.2.1 TAN/Territorial Concepts, Scales, and Spatial Reference (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 308
C.2.2 TAN/Cartography and Spatial Representation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 309
C.2.3 TAN/Geographic Information Systems (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 309
C.2.4 TAN/Remote Sensing and Earth Observation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 310
C.2.5 TAN/Census, Cadastral, and Urban Data Sources (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 310
C.2.6 TAN/Spatial Analysis, Networks, and Accessibility (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 311
C.2.7 TAN/Urban Indicators, Diagnostics, and Visualization (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 311
C.2.8 TAN/Data Quality, Uncertainty, Privacy, and Ethics (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 311
C.3 Urban Planning and Territorial Ordering (PLN) . . . 312
C.3.1 PLN/Fundamentals and Methods of Planning (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 312
C.3.2 PLN/Territorial and Regional Planning (Core Tier1: 1 hr, Core Tier2: 1 hr) . 313
C.3.3 PLN/Metropolitan Planning and Interjurisdictional Governance (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 313
C.3.4 PLN/Urban Plans, Zoning, and Land-Use Regulation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 314
C.3.5 PLN/Scenarios, Foresight, and Growth Management (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 314
C.3.6 PLN/Land Management and Value Capture (Core Tier1: 1 hr, Core Tier2: 1 hr) 314
C.3.7 PLN/Implementation Instruments and Urban Management (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 315
C.3.8 PLN/Monitoring, Evaluation, and Plan Review (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 315

C.4 Urban Design, Public Space, and Landscape (UDS) 316
C.4.1 UDS/Urban Design and Spatial Structure (Core Tier1: 1 hr, Core Tier2: 1 hr) 316
C.4.2 UDS/Streets, Blocks, and Urban Grid (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 316
C.4.3 UDS/Public Space, Plazas, and Parks (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 317
C.4.4 UDS/Walkability, Road Safety, and Active Mobility (Core Tier1: 1 hr, Core Tier2: 1 hr) 317
C.4.5 UDS/Neighborhood-Scale Design and Proximity (Core Tier1: 1 hr, Core Tier2: 1 hr) 317
C.4.6 UDS/Urban Landscape, Street Trees, and Green Infrastructure (Core Tier1: 1 hr, Core Tier2: 1 hr) 318
C.4.7 UDS/Universal Design, Accessibility, and Urban Experience (Core Tier1: 1 hr, Core Tier2: 1 hr) 318
C.4.8 UDS/Urban Project, Representation, and Evaluation Criteria (Core Tier1: 1 hr, Core Tier2: 1 hr) 319
C.5 Housing, Habitat, and Social Inclusion (HSG) 319
C.5.1 HSG/Housing Systems and Typologies (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 319
C.5.2 HSG/Housing Policy and Affordability (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 320
C.5.3 HSG/Popular Habitat, Self-Building, and Incremental Housing (Core Tier1: 1 hr, Core Tier2: 1 hr) 320
C.5.4 HSG/Comprehensive Neighborhood Upgrading (Core Tier1: 1 hr, Core Tier2: 1 hr) 320
C.5.5 HSG/Tenure, Land, and Regularization (Core Tier1: 1 hr, Core Tier2: 1 hr) . 321
C.5.6 HSG/Segregation, Gentrification, and Displacement (Core Tier1: 1 hr, Core Tier2: 1 hr) 321
C.5.7 HSG/Participation, Co-production, and the Right to the City (Core Tier1: 1 hr, Core Tier2: 1 hr) 322
C.5.8 HSG/Gender, Care, and Groups in Situations of Vulnerability (Core Tier1: 1 hr, Core Tier2: 1 hr) 322
C.6 Urban Mobility and Transport (MOB) 322
C.6.1 MOB/Mobility Systems and Transport Demand (Core Tier1: 1 hr, Core Tier2: 1 hr) 323
C.6.2 MOB/Public Transport and Intermodal Networks (Core Tier1: 1 hr, Core Tier2: 1 hr) 323
C.6.3 MOB/Pedestrian and Cycling Mobility (Core Tier1: 1 hr, Core Tier2: 1 hr) . . 324
C.6.4 MOB/Design and Management of Streets (Core Tier1: 1 hr, Core Tier2: 1 hr) 324
C.6.5 MOB/Integrated Land Use and Transport (Core Tier1: 1 hr, Core Tier2: 1 hr) 324
C.6.6 MOB/Accessibility and Equity in Mobility (Core Tier1: 1 hr, Core Tier2: 1 hr) 325
C.6.7 MOB/Urban Logistics and Freight Transport (Core Tier1: 1 hr, Core Tier2: 1 hr) 325
C.6.8 MOB/Road Safety, Emissions, and Mobility Evaluation (Core Tier1: 1 hr, Core Tier2: 1 hr) 325
C.7 Infrastructure, Services, and Urban Systems (INF) 326
C.7.1 INF/Water, Sanitation, and Urban Drainage Networks (Core Tier1: 1 hr, Core Tier2: 1 hr) 326
C.7.2 INF/Energy and Utility Networks (Core Tier1: 1 hr, Core Tier2: 1 hr) 327
C.7.3 INF/Waste and Urban Circular Economy (Core Tier1: 1 hr, Core Tier2: 1 hr) 327
C.7.4 INF/Transport Infrastructure and Connectivity (Core Tier1: 1 hr, Core Tier2: 1 hr) 327
C.7.5 INF/Urban Facilities and Services (Core Tier1: 1 hr, Core Tier2: 1 hr) 328
C.7.6 INF/Blue-Green Infrastructure and Nature-Based Solutions (Core Tier1: 1 hr, Core Tier2: 1 hr) 328
C.7.7 INF/Coordination of Networks and Urban Asset Management (Core Tier1: 1 hr, Core Tier2: 1 hr) 329
C.7.8 INF/Financing, Operation, and Maintenance of Infrastructure (Core Tier1: 1 hr, Core Tier2: 1 hr) 329
C.8 Environment, Climate, and Urban Resilience (RES) 329

C.8.1 RES/Urban Ecology and City Metabolism (Core Tier1: 1 hr, Core Tier2: 1 hr) 330
C.8.2 RES/Urban Climate, Heat Island, and Outdoor Comfort (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 330
C.8.3 RES/Climate Change: Mitigation and Adaptation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 331
C.8.4 RES/Natural Hazards and Disaster Risk Reduction (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 331
C.8.5 RES/Urban Water, Watersheds, and Sustainable Drainage (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 331
C.8.6 RES/Biodiversity, Ecological Connectivity, and Ecosystem Services (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 332
C.8.7 RES/Environmental Health, Pollution, and Exposure (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 332
C.8.8 RES/Resilience, Recovery, and Emergency Planning (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 333
C.9 Economy, Governance, and Urban Management (GOV) . . . 333
C.9.1 GOV/Urban Economy and Location (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 333
C.9.2 GOV/Land Economy and Real Estate Markets (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 334
C.9.3 GOV/Municipal Finance and Urban Budget (Core Tier1: 1 hr, Core Tier2: 1 hr) 334
C.9.4 GOV/Institutions, Competencies, and Multilevel Governance (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 335
C.9.5 GOV/Urban Law and Regulatory Frameworks (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 335
C.9.6 GOV/Urban Project and Program Management (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 335
C.9.7 GOV/Public-Private Partnerships and Community Participation (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 336
C.9.8 GOV/Public Ethics, Transparency, and Accountability (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 336
C.10 Research Methods, Technologies, and Professional Practice (TEC) . . . 337
C.10.1 TEC/Qualitative Methods and Fieldwork (Core Tier1: 1 hr, Core Tier2: 1 hr) 337
C.10.2 TEC/Quantitative Methods and Statistical Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 337
C.10.3 TEC/Participatory Research and Mixed Methods (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 338
C.10.4 TEC/Digital Twins and Three-Dimensional Urban Models (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 338
C.10.5 TEC/Sensors, Urban Data, and Civic Technology (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 339
C.10.6 TEC/Artificial Intelligence and Urban Analytics (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 339
C.10.7 TEC/Evaluation of Policies and Urban Impact (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 339
C.10.8 TEC/Communication, Interdisciplinary Collaboration, and Professional Practice (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 340

D Body of knowledge of Project Management 341
D.1 Project Management Principles (PR) . . . 341
D.1.1 PR/Stewardship . . . 342
D.1.2 PR/Create a Collaborative Project Team Environment . . . 342
D.1.3 PR/Effectively Engage with Stakeholders . . . 343
D.1.4 PR/Focus on Value . . . 343
D.1.5 PR/Recognize, Evaluate, and Respond to System Interactions . . . 343
D.1.6 PR/Demonstrate Leadership Behaviors . . . 344
D.1.7 PR/Tailor Based on Context . . . 344

D.1.8 PR/Build Quality into Processes and Deliverables . . . 345
D.1.9 PR/Navigate Complexity . . . 345
D.1.10 PR/Optimize Risk Responses . . . 345
D.1.11 PR/Embrace Adaptability and Resiliency . . . 346
D.1.12 PR/Enable Change to Achieve the Envisioned Future State . . . 346
D.2 Stakeholders (ST) . . . 346
D.2.1 ST/Stakeholder Identification and Analysis . . . 347
D.2.2 ST/Stakeholder Engagement Planning . . . 347
D.2.3 ST/Stakeholder Communication and Relationships . . . 347
D.2.4 ST/Managing Stakeholder Expectations . . . 348
D.2.5 ST/Stakeholder Influence and Power . . . 348
D.2.6 ST/Conflict and Negotiation with Stakeholders . . . 348
D.2.7 ST/Monitoring Stakeholder Engagement . . . 349
D.3 Team (TM) . . . 349
D.3.1 TM/Project Team Culture . . . 349
D.3.2 TM/Team Leadership Styles . . . 350
D.3.3 TM/Team Development and Performance . . . 350
D.3.4 TM/Motivation and Empowerment . . . 350
D.3.5 TM/Collaboration and Trust Building . . . 351
D.3.6 TM/Distributed and Virtual Teams . . . 351
D.3.7 TM/Ethics and Professional Conduct . . . 351
D.4 Development Approach and Life Cycle (DL) . . . 352
D.4.1 DL/Kickoff and Closure Activities (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 352
D.4.2 DL/Development Approach Selection . . . 352
D.4.3 DL/Predictive Approach . . . 353
D.4.4 DL/Adaptive Approach . . . 353
D.4.5 DL/Hybrid Approach . . . 353
D.4.6 DL/Project Phase Structure . . . 354
D.4.7 DL/Tailoring the Development Approach . . . 354
D.5 Planning (PL) . . . 354
D.5.1 PL/Planning Principles (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 355
D.5.2 PL/Scope and Requirements Planning (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 355
D.5.3 PL/Schedule Planning (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 355
D.5.4 PL/Cost and Budget Planning (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 356
D.5.5 PL/Resource Planning . . . 356
D.5.6 PL/Quality Planning . . . 356
D.5.7 PL/Risk and Uncertainty Planning . . . 357
D.5.8 PL/Communications and Stakeholder Engagement Planning . . . 357
D.5.9 PL/Procurement Planning . . . 357
D.5.10 PL/Integrated Project Planning . . . 358
D.6 Project Work (PW) . . . 358
D.6.1 PW/Managing Project Artifacts . . . 358
D.6.2 PW/Communication and Knowledge Management . . . 359
D.6.3 PW/Team Engagement During Execution . . . 359
D.6.4 PW/Stakeholder Engagement During Execution . . . 359
D.6.5 PW/Managing Physical Resources . . . 360
D.6.6 PW/Working with Procurements . . . 360
D.6.7 PW/Monitoring and Adapting Work . . . 360
D.7 Delivery (DV) . . . 361
D.7.1 DV/Value Definition and Delivery . . . 361
D.7.2 DV/Requirements and Scope Delivery . . . 361
D.7.3 DV/Quality Assurance and Delivery . . . 362
D.7.4 DV/Incremental and Iterative Delivery . . . 362
D.7.5 DV/Transition and Handover . . . 362
D.7.6 DV/Benefits Realization Management . . . 363
D.7.7 DV/Customer and User Satisfaction . . . 363

D.8 Measurement (MS) . . . 363
D.8.1 MS/Key Performance Indicators (Core Tier1: 1 hr, Core Tier2: 1 hr) . . . 363
D.8.2 MS/Dashboards and Information Radiators (Core Tier1: 1 hr, Core Tier2: 1 hr) 364
D.8.3 MS/Measurement Purpose and Approach . . . 364
D.8.4 MS/Earned Value and Schedule Performance . . . 364
D.8.5 MS/Forecasting and Trends . . . 365
D.8.6 MS/Stakeholder Performance Reporting . . . 365
D.8.7 MS/Lessons Learned and Knowledge Capture . . . 365
D.9 Uncertainty (UN) . . . 366
D.9.1 UN/Understanding Uncertainty and Risk . . . 366
D.9.2 UN/Risk Identification and Assessment . . . 366
D.9.3 UN/Threat and Opportunity Response . . . 367
D.9.4 UN/Ambiguity Management . . . 367
D.9.5 UN/Complexity Management . . . 368
D.9.6 UN/Volatility and Resilience Strategies . . . 368
D.9.7 UN/Monitoring and Adapting to Uncertainty . . . 368

List of Figures

2.1 Course coding scheme. 9
2.2 Credits by area by semester 34
2.3 Distribution of courses by area considering credits. 35
2.4 Distribution of credits by course levels. 35
2.5 BasicSciences 39
2.6 DCB 40

3.1 Connection Map. AR1B1 Introduction to BIM 42
3.2 Connection Map. AR1D1 Design Studio I 45
3.3 Connection Map. AR1R1 Geometry and Analog Drawing 49
3.4 Connection Map. MA100 Basic Mathematics 52
3.5 Connection Map. MA111 Calculus I 54
3.6 Connection Map. EG163 Communication I 56
3.7 Connection Map. EG164 Digital Competencies Development 59
3.8 Connection Map. EG165 Strategies for Autonomous Learning 62
3.9 Connection Map. EG166 Basic Mathematics 65
3.10 Connection Map. AR1B2 Parametric Modeling and Generative Design 68
3.11 Connection Map. AR1D2 Design Studio II 72
3.12 Connection Map. AR2R1 Digital Drafting 77
3.13 Connection Map. ID101 Technical and professional English I 80
3.14 Connection Map. EG263 Communication II 83
3.15 Connection Map. EG264 Philosophy 86
3.16 Connection Map. EG265 Peruvian Territory. National Defense and Security 89
3.17 Connection Map. AR1D3 Design Studio III 92
3.18 Connection Map. AR2B1 Multidisciplinary Coordination 96
3.19 Connection Map. AR3R1 3D Modeling and Virtual Animation 99
3.20 Connection Map. ID102 Technical and professional English II 103
3.21 Connection Map. EG364 Ethics 107
3.22 Connection Map. EG366 Personal Development and Leadership 110
3.23 Connection Map. AR1T1 Digital Topography 113
3.24 Connection Map. AR2B2 BIM Execution Planning 116
3.25 Connection Map. AR2D1 Design Studio IV 119
3.26 Connection Map. ID201 Technical and professional English III 123
3.27 Connection Map. EG363 Ecology and Sustainable Development 127
3.28 Connection Map. EG365 Peru's Problems and Challenges in a Global World 130
3.29 Connection Map. AR2B3 BIM Scheduling and Cost 133
3.30 Connection Map. AR2D2 Design Studio V 136
3.31 Connection Map. ID202 Technical and professional English IV 141
3.32 Connection Map. AR2D3 Design Studio VI 145
3.33 Connection Map. AR3B1 Structural and MEP Coordination 149
3.34 Connection Map. ID203 Technical and professional English V 152
3.35 Connection Map. AR3B2 Sustainability and Circular Economy 156
3.36 Connection Map. AR3D1 Design Studio VII 159
3.37 Connection Map. AR400 Scientific Research Methodology 163

3.38 Connection Map. AR3B3 Facilities Management 167
3.39 Connection Map. AR3D2 Design Studio VIII 170
3.40 Connection Map. AR401 Statistics and Research Instruments 174
3.41 Connection Map. AR3B4 Heritage and Infrastructure 178
3.42 Connection Map. AR3D3 Design Studio IX 182
3.43 Connection Map. AR402 Research Workshop 186
3.44 Connection Map. AR3D4 Design Studio X 189
3.45 Connection Map. AR403 Research Work 194
3.46 Connection Map. AR404 Innovation and Entrepreneurship 196
3.47 Connection Map. AR4B1 AI-Assisted Automation 199

List of Tables

2.1 General Architecture topics by course 1st Semester 14
2.2 General Architecture topics by course from 2nd to 3rd Semester 15
2.3 General Architecture topics by course from 4th to 7th Semester (Part 1 of 2) 17
2.4 General Architecture topics by course from 4th to 7th Semester (Part 2 of 2) 18
2.5 General Architecture topics by course from 8th to 10th Semester (Part 1 of 2) 19
2.6 General Architecture topics by course from 8th to 10th Semester (Part 2 of 2) 20
2.7 Architectural Sciences topics by course 1st Semester 20
2.8 Architectural Sciences topics by course from 2nd to 3rd Semester 21
2.9 Architectural Sciences topics by course from 4th to 7th Semester 21
2.10 Architectural Sciences topics by course from 8th to 10th Semester 21
2.11 Urbanism topics by course 1st Semester 22
2.12 Urbanism topics by course from 2nd to 3rd Semester 22
2.13 Urbanism topics by course from 4th to 7th Semester 23
2.14 Urbanism topics by course from 8th to 10th Semester 23
2.15 Project Management topics by course 1st Semester 24
2.16 Project Management topics by course from 2nd to 3rd Semester 24
2.17 Project Management topics by course from 4th to 7th Semester 24
2.18 Project Management topics by course from 8th to 10th Semester 25
2.19 Outcomes by course 1st Semester 26
2.20 Outcomes by course 2nd to 3rd Semester 27
2.21 Outcomes by course 4th to 7th Semester 28
2.22 Outcomes by course 8th to 10th Semester 29
2.23 Distribution of credits by area by semester 33

A.1 List of KUs in the Architectural Design area. 213
A.2 List of KUs in the History, Theory and Criticism area. 218
A.3 List of KUs in the Building Technology and Construction area. 224
A.4 List of KUs in the Structural Systems for Architecture area. 228
A.5 List of KUs in the Environmental Systems and Sustainability area. 233
A.6 List of KUs in the Urban Design and Planning area. 238
A.7 List of KUs in the Professional Practice and Ethics area. 243
A.8 List of KUs in the Architectural Representation and Digital Tools area. 247
A.9 List of KUs in the Interior Architecture and Space Design area. 252
A.10 List of KUs in the Heritage Conservation and Restoration area. 257
A.11 List of KUs in the Landscape Architecture area. 260
A.12 List of KUs in the Real Estate Development and Construction Economics area. 265
A.13 List of KUs in the Research Methods and Emerging Technologies area. 269
A.14 List of KUs in the Architectural Regulations and Standards area. 274
A.15 List of KUs in the Building Information Modeling area. 276

B.1 List of KUs in the Calculus and Analysis area. 289
B.2 List of KUs in the Algebra and Number Theory area. 292
B.3 List of KUs in the Geometry and Topology area. 293
B.4 List of KUs in the Classical Mechanics area. 294

B.5 List of KUs in the Probability Theory area. 297
B.6 List of KUs in the Descriptive Statistics and Data Analysis area. 299
B.7 List of KUs in the Statistical Inference area. 300
B.8 List of KUs in the Regression and Statistical Models area. 301

C.1 List of KUs in the Foundations of the City and Urbanization area. 304
C.2 List of KUs in the Territorial Analysis and Urban Information Systems area. 308
C.3 List of KUs in the Urban Planning and Territorial Ordering area. 312
C.4 List of KUs in the Urban Design, Public Space, and Landscape area. 316
C.5 List of KUs in the Housing, Habitat, and Social Inclusion area. 319
C.6 List of KUs in the Urban Mobility and Transport area. 323
C.7 List of KUs in the Infrastructure, Services, and Urban Systems area. 326
C.8 List of KUs in the Environment, Climate, and Urban Resilience area. 330
C.9 List of KUs in the Economy, Governance, and Urban Management area. 333
C.10 List of KUs in the Research Methods, Technologies, and Professional Practice area. . . 337

D.1 List of KUs in the Project Management Principles area. 342
D.2 List of KUs in the Stakeholders area. 346
D.3 List of KUs in the Team area. 349
D.4 List of KUs in the Development Approach and Life Cycle area. 352
D.5 List of KUs in the Planning area. 354
D.6 List of KUs in the Project Work area. 358
D.7 List of KUs in the Delivery area. 361
D.8 List of KUs in the Measurement area. 363
D.9 List of KUs in the Uncertainty area. 366

Acknowledgments

In addition to the direct authors of this document, we also wish to express our gratitude to other colleagues from various universities in the country and around the world who have kindly devoted part of their time to provide us with their suggestions.

This entire team assumed as a premise that the center of our effort is the academic and human education of the students, to shape them into agents of positive and disruptive change in society.

We wish to thank all of them for their contribution, which has made it possible to produce this document— unique of its kind in our country—that will serve to lay the foundations for a stronger career in this area that we have had the opportunity to study and of which we are proud to be a part: **Architecture**

Abreviaturas

.

Chapter 1

Introducción

La arquitectura ha experimentado un desarrollo fundamental y continuo desde los albores de la civilización, consolidándose como la disciplina mediante la cual las sociedades dan forma, sentido y función a los espacios en los que viven, trabajan y se reúnen. Es el motor del diseño de la vivienda, los edificios públicos, los hitos culturales y los entornos urbanos, transformando de manera tangible y duradera el entorno edificado y la calidad de vida de las comunidades.

El ejercicio de la arquitectura ha marcado cada era de la historia, desde el refugio vernáculo hasta los complejos de uso mixto contemporáneos que antes eran inimaginables. La continua evolución de sus métodos, materiales y tecnologías está transformando la concepción, el diseño y la ejecución de edificaciones y ciudades. Su influencia es decisiva en la sostenibilidad ambiental, la conservación del patrimonio, el diseño urbano y la seguridad y dignidad de los espacios en los que vivimos y trabajamos.

Para darnos una idea de la relevancia e importancia estratégica que esta disciplina tiene para el desarrollo de nuestro país, basta mencionar que la inversión en vivienda y espacio público bien diseñados es uno de los principales indicadores de bienestar social y competitividad urbana. Las edificaciones y espacios públicos dados forma por los arquitectos constituyen el soporte físico para todas las demás actividades productivas, culturales y sociales.

Si bien el núcleo de la profesión es claro y universal: la integración de consideraciones de diseño, técnicas y humanas para crear espacios que sirvan al público, la formación académica en este campo puede presentarse bajo diferentes énfasis, como Arquitectura con mención en Diseño Urbano, Arquitectura Paisajista, Conservación del Patrimonio y Arquitectura de Interiores, entre otros. Esta diversidad refleja la amplitud y especialización dentro de la propia disciplina. Sin embargo, resulta fundamental que exista un cuerpo de conocimiento central, sólido y compartido que garantice la competencia profesional y el bienestar público, independientemente del énfasis curricular particular.

Históricamente, la arquitectura se desarrolló a partir de tradiciones constructivas vernáculas y gremios de artesanos, evolucionando hacia una disciplina académica formal a través de escuelas como la École des Beaux-Arts y, más tarde, la Bauhaus. En las universidades modernas, se consolidó como una disciplina independiente, diferenciándose de la ingeniería civil, con su propio marco de acreditación (el Acuerdo de Canberra). Su reconocimiento académico se basa en un cuerpo de conocimiento profundo que integra diseño, historia y teoría, tecnología de la construcción y sistemas ambientales aplicados a problemas del mundo real.

En Peru, la calidad de la vivienda y el desarrollo urbano es una prioridad nacional que demanda profesionales de la arquitectura altamente capacitados, éticos e innovadores. Las instituciones de educación superior tienen el reto y la responsabilidad de formar a estos profesionales con los más altos estándares internacionales, respondiendo a los desafíos específicos del territorio y alineándose con las tendencias globales en sostenibilidad, digitalización y conservación del patrimonio.

La Arquitectura reconoce esta necesidad imperante y asume el compromiso de liderar este esfuerzo formativo. No puede quedar al margen de este imperativo de excelencia y actualización, en el cual mantenerse a la vanguardia es una obligación para contribuir efectivamente al desarrollo nacional y al bienestar de la sociedad.

1.1 Legal framework

1.1.1 General legal framework

The curricular design of this program is grounded in the general legal framework currently in force in Peru: the Political Constitution of Peru, which recognizes university autonomy (art. 18), and University Law No. 30220, which regulates the creation, operation, and purposes of Peruvian universities.

In addition, the professional practice of architecture is governed by three specific laws: Law No. 14085, which created the Peruvian College of Architects (Colegio de Arquitectos del Perú, CAP); Law No. 16053, the Law of Professional Practice of the Architect; and Law No. 28966, which complements the regulatory framework for the professional practice of architects, as regulated by Supreme Decree No. 005-2011-VIVIENDA. These laws establish mandatory membership in the CAP as a requirement for professional practice, which directly underpins the graduate profile and degree requirements described in this document.

1.1.2 Institutional regulatory framework

This curricular plan is also framed by the internal regulations of the Universidad Privada de Tacna (UPT): the institutional Statute, aligned with University Law No. 30220 (arts. 20, 21, 22, and 23); the General Regulations (arts. 14, 15, 16, and 17); and the institution's current Mission, Vision, and Educational Model, which guide the competency-based training approach adopted in this program.

1.2 Conclusions of the curricular plan review

1.2.1 Justification of the program

The training of architects responds to a permanent societal need: planning, designing, and materializing the built environment in which human life unfolds. As Peruvian cities grow and densify, the demand for professionals able to reconcile design, livability, sustainability, and technical regulation becomes increasingly critical, both in the public sphere (urban planning, social housing, heritage) and in the private sector (real-estate development, corporate and industrial building).

This need takes on a particular character in southern Peru. Tacna, home to Universidad Privada de Tacna (UPT), is a border city with its own urban dynamics: it concentrates commercial and population flows with northern Chile, experiences growth pressure associated with regional mining activity (Toquepala, Cuajone), and faces the same housing, basic-services, and territorial-planning challenges as the rest of the country, but with a far more limited supply of architecture training than the one concentrated in Lima. Training architects in Tacna is therefore not a replica of a Lima-based program, but a direct response to the need for professionals able to intervene in that specific border, mining, and binational context, without graduates having to migrate to the capital to be trained.

The profession is also practiced along two complementary paths that this curricular plan seeks to address simultaneously. On one hand, independent practice or work in architecture firms, oriented toward the design of high-quality buildings and public spaces. On the other, engagement with real-estate development, construction, and larger-scale urban-project management firms, where the architect participates as a leader of multidisciplinary teams. Both paths increasingly demand digital competencies (BIM modeling, parametric representation), environmental sensitivity, and the ability to work under international regulatory and accreditation frameworks, such as the Canberra Accord described in this document's Basic Definitions section.

Training professionals under these standards is not merely an academic requirement but a commitment to the development of the territory: a high-quality built environment connects communities, facilitates commerce, improves safety and quality of life, and ultimately constitutes a precondition for the sustainable economic and social development of the region and the country.

1.2.2 Program supply and demand

The supply of accredited architecture programs in southern Peru is comparatively small relative to the concentration in Lima, which positions the Tacna region –and, by extension, the macro-south

and northern Chile– as an area of influence with training demand not fully covered locally. The specific quantitative indicators on applicants, available seats, and graduate employability (surveys of graduates and employers, following the methodology described in Step 1 of the UPT Curricular Design Guide) must be periodically updated by the Office of Academic Processes and Registration with the institution's own data.

1.2.3 Problems facing the profession

The practice of architecture in Peru faces structural challenges that this curriculum must prepare professionals to confront, not merely describe.

The most evident is the housing deficit. According to figures from the National Institute of Statistics and Informatics (INEI) for 2024, 10.1% of households nationwide present a housing deficit (9.4% in urban areas and 12.9% in rural areas), equivalent to a national gap of close to 1.9 million dwellings: 587 thousand of quantitative deficit (dwellings that still need to be built) and 1.3 million of qualitative deficit (existing dwellings with structural, sanitation, or overcrowding deficiencies requiring improvement) (INEI, Living Conditions in Peru, 2024-2025). Annual demand for new housing far exceeds the formal supply, which largely explains the informal urban growth that characterizes most of the country's cities, Tacna included.

Added to this deficit is the seismic and climate vulnerability of the built environment: Peru sits on the Pacific Ring of Fire, so seismic- resistant design and construction are not an optional curriculum content but a mandatory professional competency. Territorial planning, moreover, tends to lag behind actual urban growth, producing settlements without adequate basic services, especially on the periphery of mid-sized cities like Tacna.

Finally, there is a relevant digital gap in professional practice. The Peruvian State has begun requiring the BIM (Building Information Modeling) methodology on public investment projects, through Supreme Decree No. 289-2019-EF and its update, Supreme Decree No. 108-2021-EF (Plan BIM Perú, Ministry of Economy and Finance), but this requirement does not yet reach private practice or regions outside Lima uniformly. The curriculum must therefore train professionals able not only to operate within these current limits, but to actively close the gap between national regulation and regional practice.

1.2.4 State of the art

Contemporary architectural education is oriented toward integrating four major technological and conceptual domains, which this curriculum incorporates transversally rather than as isolated content.

The first is digital building-information design and management. In Peru, the adoption of Building Information Modeling (BIM) has stopped being a distant international trend and become public policy: Supreme Decree No. 289-2019-EF established the progressive incorporation of BIM in public investment projects, later updated by Supreme Decree No. 108-2021-EF (Plan BIM Perú, Ministry of Economy and Finance). Training graduates who master these tools is therefore not a pedagogical option but a growing regulatory requirement of the Peruvian professional market itself.

The second domain is environmental sustainability and climate resilience: bioclimatic design, energy efficiency, water management, and circular economy of construction materials, in a context where climate change is intensifying phenomena such as floods, droughts, and extreme thermal events that directly affect the built environment.

The third domain is participatory urban design and the regeneration of historic centers and informal settlements, understood not as one-off interventions but as continuous territorial-management processes that require coordination among architects, local authorities, and communities.

The fourth domain is digital fabrication and parametric modeling, technologies that are changing the relationship between conceptual design and its physical materialization, allowing structural and formal solutions to be explored that were previously unfeasible with traditional drafting methods.

International trends –smart cities, net-zero-energy buildings, urban digital twins– require architecture programs to continuously update their curricula. It is important to remember, however, that academia should not limit itself to teaching the latest version of a specific software or tool: training must be anchored in the design, structural, and sustainability principles that underlie those tools, so that graduates can adapt to the technologies that emerge after their graduation.

1.2.5 Similar experiences

The design of this curricular plan took as reference nationally and internationally recognized architecture programs, contrasting their graduate profiles, curricular organization, and pedagogical emphasis against the particular needs of the Universidad Privada de Tacna (UPT) context.

At the national level, two programs with a well-established track record were reviewed. The Faculty of Architecture, Urbanism and Arts (FAUA) of the Universidad Nacional de Ingeniería, founded in 1910 and the oldest in the country, contributes a perspective strongly oriented toward the integration of architecture, urbanism, and engineering. The Faculty of Architecture and Urbanism of the Pontificia Universidad Católica del Perú, focused on the challenges of Lima's metropolitan scale and the diversity of Peru's territory and regions, contributes an emphasis on applied research and social outreach. As a regional reference closer to Tacna's context, the Faculty of Architecture and Urbanism of the Universidad Nacional de San Agustín de Arequipa was also reviewed, for its experience training architects for mid-sized cities in southern Peru.

Internationally, the Architecture program of the Universidad de Chile was taken as a reference, holding international accreditation from the Royal Institute of British Architects (RIBA) since 1992, renewed in 2018 – making it a direct reference case for how a Latin American program sustains, over time, an international recognition aligned with the Canberra Accord competency framework that structures this curriculum.

Contrasting these four programs –two from Lima, one from southern Peru, and one Chilean program with current international accreditation– made it possible to identify both practices common to the region (the design studio as the articulating axis, training in sustainability and heritage) and opportunities for differentiation for Universidad Privada de Tacna (UPT): an explicit emphasis on Tacna's border, mining, and binational context, and an early incorporation of digital competencies (BIM, parametric modeling) aligned with the national policy described in the State of the Art section.

1.3 Basic definitions

Architecture, in its fundamental definition, is the discipline that integrates design, technical, environmental, and human considerations to conceive, plan, and build spaces and structures that serve the well-being of people and society.

Unlike other, more recently formalized disciplines, architecture has its own international accreditation framework, independent from that of civil engineering: the **Canberra Accord**, signed in 2008 in Canberra, Australia, by a group of national architectural accreditation and registration bodies. This accord establishes mutual recognition of academic programs accredited by its signatory bodies, and defines the graduate attributes that an architecture program must guarantee in its graduates.

Worldwide, the broader complementary reference on architectural education is the **UNESCO-UIA Charter for Architectural Education**, jointly promoted by the *Union Internationale des Architectes* (UIA) and UNESCO. This charter proposes shared minimum principles and objectives for architectural education around the world, while recognizing the diversity of cultural, climatic, and constructive contexts in which the profession is practiced.

In Peru, the professional practice of architecture is regulated by the Colegio de Arquitectos del Perú (CAP, the Peruvian College of Architects), the body that grants the professional title of architect to graduates of accredited university programs and oversees compliance with the profession's ethical and technical standards.

An important conceptual distinction arises when contrasting the use of the term *arquitecto* in the Spanish language versus the English language. In the Latin American context, *arquitecto* is a professional title conferred exclusively upon those who have completed accredited university education in architecture and meet the corresponding licensure requirements.

In contrast, in the Anglo-Saxon sphere, the word *architect* is frequently used figuratively to denote roles in other disciplines, such as *software architect*, *solutions architect*, *information architect*, or *data architect*, which describe design and systems-organization functions but do not correspond to professionals qualified as architects under the traditional regulation of buildings and the built environment.

This semantic difference can generate confusion when these job titles are imported into the national professional context. It is therefore essential to maintain clarity in the naming of architecture degree

programs and titles, ensuring they respond to the formal definition just cited and to the competency framework established internationally by the Canberra Accord.

It is precisely this accord that gives rise to the ICACIT-AAC-Canberra learning outcomes framework that structures this curriculum, ensuring that our graduates meet an internationally recognized standard of competencies for the practice of architecture.

1.4 Admission profile

The applicant to enter the Escuela Profesional de Arquitectura at Universidad Privada de Tacna (UPT) must have:
Knowledge of:

1. Fundamental concepts of mathematics (algebra, geometry, trigonometry, calculus).
2. Basic principles of physics applicable to building design and construction.
3. Elementary notions of drawing, geometry, and spatial visualization.
4. Socioeconomic, cultural, and environmental context of their local and global environment.

Skills to:

1. Analyze complex problems, identify their components and cause-effect relationships.
2. Apply logical-mathematical reasoning to model and solve practical situations.
3. Interpret technical information, graphs, and quantitative data accurately.
4. Express ideas clearly and structured, both orally and in writing, as well as graphically.
5. Work methodically and persistently in solving challenging design problems.
6. Synthesize information from diverse sources and generate well-founded conclusions.
7. Adapt study and learning methods to technical, abstract, and visual content.
8. Collaborate effectively in work teams.

Attitudes of:

1. Genuine interest in the creative and technical design of the built environment.
2. Willingness for active learning, experimentation, and innovation.
3. Responsibility towards the social, environmental, and ethical impact of design.
4. Intellectual curiosity and openness to continuous and multidisciplinary learning.

1.5 Program objectives

Después de cinco años de egresado de la carrera profesional de Arquitectura, nuestros profesionales deben ser capaces de:

1. Design, document, and oversee the construction of buildings and urban spaces that comply with technical, safety, and accessibility standards, exceeding sector expectations.
2. Lead multidisciplinary teams in complex projects using modern management and effective communication.
3. Implement innovative solutions integrating digital design tools and sustainability principles.
4. Communicate design proposals and results clearly and precisely to diverse audiences.
5. Continuously adapt to new standards, technologies, and methodologies through lifelong learning.
6. Practice the profession with ethical, social, and environmental responsibility, prioritizing public welfare.
7. Contribute to professional advancement through participation in professional associations and development of best practices.

1.6 Graduate profile

1.6.1 Career Outcomes

Upon completing this program, the graduate will have achieved the following outcomes:

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment.

AG-A02) Applies ethical principles and the standards of professional architectural practice, respecting the legal framework and human diversity.

AG-A03) Performs effectively as an individual and as a member or leader in diverse, inclusive teams, in multidisciplinary in-person and remote environments.

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences.

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments.

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change.

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions.

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design.

AG-A09) Creates architectural designs that satisfy aesthetic and technical requirements.

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions.

AG-A11) Demonstrates knowledge of the physical problems and technologies that allow buildings to provide internal comfort and protection within environmental parameters.

AG-A12) Possesses the design skills needed to satisfy building users' requirements within cost constraints and building regulations.

AG-A13) Demonstrates knowledge of the means to achieve ecologically responsible design and environmental conservation and rehabilitation.

AG-A14) Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture.

AG-A15) Understands the relationship between people, buildings, and their environment, and the need to relate buildings and spaces to human scale and needs.

The competences and/or outcomes proposed in this curriculum correspond to the competences and/or outcomes proposed by Accreditation Institute for Computing, Engineering and Technology (ICACIT).

1.6.2 Learning Outcomes

Each KU within a KA lists both a set of topics and the learning outcomes that students must achieve with respect to the specified topics. Learning outcomes are not uniform in size and do not have a uniform allocation of curricular hours; topics with the same number of hours may have very different numbers of associated learning outcomes.

Each learning outcome has an associated level of mastery. In defining the different levels we took as a reference other curricular approaches, especially Bloom's taxonomy, which has been well explored within Arquitectura. In this document Bloom's levels were not applied directly, in part because several of them are determined by the pedagogical context, which would introduce too much plurality into a document of this type; and in part because the mastery levels are meant to be indicative and not to impose theoretical restrictions on the users of this document.

We use three expected levels of mastery, which are:

Level 1 Familiarity(*Familiarity*) : The student **understands** basic concepts. Answers: **"What is this?"**

Level 2 Usage(*Usage*) : The student **applies** concepts practically. Answers: **"How to use this?"**

Level 3 Assessment(*Assessment*) : The student **evaluates and justifies** approaches. Answers: **"Why this method?"**

For example, to evaluate the levels of mastery, let us consider the notion of material selection in architectural design. At the "familiarity" level, a student is expected to know the types of materials available (wood, concrete, steel, glass, masonry), their general properties, and to understand why this selection is crucial to the success of any design.

To demonstrate mastery of the "Usage" level, the student must be able to apply technical criteria to select materials in simple cases, using property tables, technical standards, and considering factors such as durability, cost and availability.

At the "Assessment" level, the student would be required to analyze multiple material alternatives for a complex building, considering not only mechanical and structural properties but also environmental impact, sustainability, life cycle, applicable building codes and socioeconomic context, in order to select the optimal option, justifying the decision with a comprehensive and ethical approach.

1.6.3 Graduate profile

The graduate of the Architecture Professional Program is able to:

1. Design buildings and urban spaces applying building codes and structural, environmental, and accessibility standards to guarantee safety and habitability.
2. Plan and manage design and construction projects using modern methodologies (BIM, agile project management) to optimize resources and costs.
3. Develop architectural programs and spatial solutions that respond to the needs of users, site conditions, and climate.
4. Produce construction documentation (drawings, specifications, details) coordinated with structural, mechanical, and electrical systems.
5. Oversee construction works, coordinating teams and supervising quality, safety, and regulatory compliance.
6. Apply urban design and planning principles to the design of public space, housing, and mixed-use developments.
7. Integrate sustainability and circular-economy criteria into resilient, energy-efficient buildings, evaluating environmental impact.
8. Use specialized software (Revit, AutoCAD, Rhino, SketchUp, Lumion) for architectural modeling and project management.
9. Communicate design proposals through drawings, models, renderings, and presentations to regulatory bodies and communities.
10. Continue graduate studies in urban design, heritage conservation, or project management, leading innovation in the built environment.

1.6.4 Professional Profile

The professional in Arquitectura has the following characteristics:

- Design buildings and urban spaces applying building codes and structural, environmental and accessibility standards to guarantee safety and habitability.
- Plan and manage design and construction projects using modern methodologies (BIM, agile project management) to optimize resources and costs.
- Develop architectural programs and spatial solutions that respond to the needs of users, site conditions and climate.
- Produce construction documentation (drawings, specifications, details) coordinated with structural, mechanical and electrical systems.
- Oversee construction works, coordinating teams and supervising quality, safety and regulatory compliance.
- Apply urban design and planning principles to the design of public space, housing and mixed-use developments.

- Integrate sustainability and circular-economy criteria into resilient, energy-efficient buildings, evaluating environmental impact.
- Use specialized software (Revit, AutoCAD, Rhino, SketchUp, Lumion) for architectural modeling and project management.
- Communicate design proposals through drawings, models, renderings and presentations to regulatory bodies and communities.
- Continue specialized studies in urban design, heritage conservation or project management, leading innovation in the built environment.

1.7 Resources to teach

A innovative professional must always stay up to date with the latest advances in their field. The latest developments in this discipline are not necessarily found in traditional books. We must use publications from indexed journals with worldwide circulation as a primary source of up-to-date knowledge.

For this reason, we rely on institutional subscriptions to specialized databases such as the Avery Index to Architectural Periodicals, JSTOR, Scopus, Web of Science, and other professional associations relevant to architecture. It is recommended that faculty use this material to discuss in class the trends, innovations, and cutting-edge developments in all areas of the specialty.

Studio and workshop infrastructure must also be updated according to the technological progress specific to the discipline, and this implies constant renovations to ensure that students develop practical competencies aligned with current professional standards.

The physical resources regarding studios and workshops for each course are detailed in Chapter 6.

1.8 Document Organization

The remainder of this document is organized as follows: Chapter 1 defines and explains the field of action of the Arquitectura, in addition to providing a very brief explanation of the different programs related to this discipline.

In Chapter A, we present the Knowledge Areas of General Architecture, indicating the topics and learning objectives of each subject,

In Chapter B, we present the Knowledge Areas of Architectural Sciences, indicating the topics and learning objectives of each subject,

In Chapter C, we present the Knowledge Areas of Urbanism, indicating the topics and learning objectives of each subject,

In Chapter D, we present the Knowledge Areas of Project Management, indicating the topics and learning objectives of each subject,

Chapter 2 contains the distribution by semesters, by areas, by levels, graphical view of the curriculum, comparison with various international proposals, distribution of topics per course, as well as the distribution of skills per subject.

Chapter 3 contains detailed information for each of the courses, including the skills to which it contributes, bibliography per unit, as well as the minimum number of hours per unit.

In Chapter 4 we can observe a list of courses by professor and of professor by course.

In Chapter 5, the equivalence tables with other curricula are presented.

In Chapter 6, a suggestion of the laboratories required for teaching classes is presented, which could vary depending on the number of students.

Chapter 2

Curricula 2027

2.1 Course Coding

Courses are classified into 4 levels:

- **Introductory** Code 1.. example: CS100
- **Intermediate** Code 2.. example: MA200
- **Advanced** Code 3.. example: IS370
- **Capstone Project** Code 4.. example: CS403

The courses are encoded under the scheme shown in Figure 2.1.

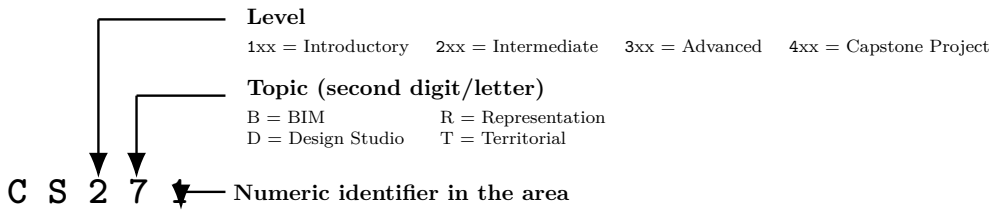


Figure 2.1: Course coding scheme.

The course type is determined by the initial letters. The possible codes for these types are:

1. **AR** Área de Arquitectura (*Architecture* – AR);
2. **MA** Matemáticas (MA);
3. **ID** Área de Idiomas.
4. **EG** Área de Formación General

At the same time, and according to current university law, courses are classified into:

- General studies
- Specific
- Specialization

2.2 Curricular Structure

The list of courses is shown below:

TH = Theory Hours, PR = Practice Hours, CR = Credits, T = Type of Course.

M = Mandatory, E = Elective.

Primer Semestre							
Código	**Curso**	**Área**	**HT**	**HP**	**CR**	**T**	**Requisitos**
AR1B1	Introduction to BIM (Pág 41)	Specific	4	4	4	O	
AR1D1	Design Studio I (Pág 45)	Specific	4	4	4	O	
AR1R1	Geometry and Analog Drawing (Pág 49)	Specific	2	4	4	O	
MA100	Basic Mathematics (Pág 52)	General Studies	3	4	5	O	
MA111	Calculus I (Pág 54)	General Studies	3	4	5	O	
EG163	Communication I (Pág 56)	General Studies	4		4	O	
EG164	Digital Competencies Development (Pág 59)	General Studies	1	4	3	O	
EG165	Strategies for Autonomous Learning (Pág 62)	General Studies	3		3	O	
EG166	Basic Mathematics (Pág 65)	General Studies	2	4	4	O	
					26		

Segundo Semestre

Código	Curso	Área	HT	HP	CR	T	Requisitos
AR1B2	Parametric Modeling and Generative Design (Pág 68)	Specific	4	4	4	O	AR1B1 (1er Sem)
AR1D2	Design Studio II (Pág 72)	Specific	4	4	4	O	AR1D1 (1er Sem)
AR2R1	Digital Drafting (Pág 77)	Specific	2	4	4	O	AR1R1 (1er Sem)
ID101	Technical and professional English I (Pág 80)	General Studies	1	2	2	O	
EG263	Communication II (Pág 83)	General Studies	4		3	O	EG163 (1er Sem)
EG264	Philosophy (Pág 86)	General Studies	3		3	O	
EG265	Peruvian Territory. National Defense and Security (Pág 89)	General Studies	3		3	O	
					23		

Tercer Semestre

Código	Curso	Área	HT	HP	CR	T	Requisitos
AR1D3	Design Studio III (Pág 92)	Specific	4	4	4	O	AR1D2 (2do Sem)
AR2B1	Multidisciplinary Coordination (Pág 96)	Specific	4	4	4	O	AR1B2 (2do Sem)
AR3R1	3D Modeling and Virtual Animation (Pág 99)	Specific	2	4	4	O	AR2R1 (2do Sem)
ID102	Technical and professional English II (Pág 103)	General Studies	1	2	2	O	ID101 (2do Sem)
EG364	Ethics (Pág 107)	General Studies	3		3	O	EG264 (2do Sem)
EG366	Personal Development and Leadership (Pág 110)	General Studies	3		3	O	
					20		

Cuarto Semestre

Código	Curso	Área	HT	HP	CR	T	Requisitos
AR1T1	Digital Topography (Pág 113)	Specific	1	4	3	O	
AR2B2	BIM Execution Planning (Pág 116)	Specific	4	4	4	O	AR2B1 (3er Sem)
AR2D1	Design Studio IV (Pág 119)	Specific	4	4	4	O	AR1D3 (3er Sem)
ID201	Technical and professional English III (Pág 123)	General Studies	1	2	2	O	ID102 (3er Sem)
EG363	Ecology and Sustainable Development (Pág 127)	General Studies	3		3	O	
EG365	Peru's Problems and Challenges in a Global World (Pág 130)	General Studies	3		3	O	
					19		

Quinto Semestre

Código	Curso	Área	HT	HP	CR	T	Requisitos
AR2B3	BIM Scheduling and Cost (Pág 133)	Specific	4	4	4	O	AR2B2 (4to Sem)
AR2D2	Design Studio V (Pág 136)	Specific	4	4	4	O	AR2D1 (4to Sem)
ID202	Technical and professional English IV (Pág 141)	General Studies	1	2	2	O	ID201 (4to Sem)
					10		

Sexto Semestre

Código	Curso	Área	HT	HP	CR	T	Requisitos
AR2D3	Design Studio VI (Pág 145)	Specific	4	4	4	O	AR2D2 (5to Sem)
AR3B1	Structural and MEP Coordination (Pág 149)	Specific	4	4	4	O	AR2B3 (5to Sem)
ID203	Technical and professional English V (Pág 152)	General Studies	1	2	2	O	ID202 (5to Sem)
					10		

Séptimo Semestre							
Código	**Curso**	**Área**	**HT**	**HP**	**CR**	**T**	**Requisitos**
AR3B2	Sustainability and Circular Economy (Pág 156)	Specific	4	4	4	O	AR3B1 (6^{to} Sem)
AR3D1	Design Studio VII (Pág 159)	Specific	4	4	4	O	AR2D3 (6^{to} Sem)
AR400	Scientific Research Methodology (Pág 163)	Specialization	3		3	O	
					11		

Octavo Semestre							
Código	**Curso**	**Área**	**HT**	**HP**	**CR**	**T**	**Requisitos**
AR3B3	Facilities Management (Pág 167)	Specific	4	4	4	O	AR3B2 (7^{mo} Sem)
AR3D2	Design Studio VIII (Pág 170)	Specific	4	4	4	O	AR3D1 (7^{mo} Sem)
AR401	Statistics and Research Instruments (Pág 174)	Specialization	2	2	3	O	AR400 (7^{mo} Sem)
					11		

Noveno Semestre							
Código	**Curso**	**Área**	**HT**	**HP**	**CR**	**T**	**Requisitos**
AR3B4	Heritage and Infrastructure (Pág 178)	Specific	4	4	4	O	AR3B3 (8^{vo} Sem)
AR3D3	Design Studio IX (Pág 182)	Specific	4	4	4	O	AR3D2 (8^{vo} Sem)
AR402	Research Workshop (Pág 186)	Specialization	4		4	O	AR401 (8^{vo} Sem)
					12		

Décimo Semestre							
Código	**Curso**	**Área**	**HT**	**HP**	**CR**	**T**	**Requisitos**
AR3D4	Design Studio X (Pág 189)	Specific	4	4	4	O	AR3D3 (9^{no} Sem)
AR403	Research Work (Pág 194)	Specialization	4		4	O	AR402 (9^{no} Sem)
AR404	Innovation and Entrepreneurship (Pág 196)	Specialization	4		4	O	
AR4B1	AI-Assisted Automation (Pág 199)	Specific	4	4	4	O	AR3B4 (9^{no} Sem)
					16		

Total de créditos de la carrera: 158 .

2.3 Topics distributed by course

2.3.1 General Architecture topics/course

		First Sem									.
	Knowledge Units of General Architecture **Courses →**	AR1B1	AR1D1	AR1R1	MA100	MA111	EG163	EG164	EG165	EG166	Total
★	ADG/Foundations of Architectural Design (1 hour Core-Tier1, 1 hour Core-Tier2)		10								10
★	ADG/Design Process and Creative Methods (1 hour Core-Tier1, 1 hour Core-Tier2)		16								16
★	REP/Orthographic Drawing and Conventions (1 hour Core-Tier1, 1 hour Core-Tier2)		14	32							46
★	REP/Graphic Symbols and Drafting Conventions (1 hour Core-Tier1, 1 hour Core-Tier2)			32							32
★	BIM/BIM Fundamentals and Authoring (1 hour Core-Tier1, 1 hour Core-Tier2)	24									24
★	BIM/BIM-Based Construction Documentation (1 hour Core-Tier1, 1 hour Core-Tier2)	24									24
★	BIM/BIM Model Organization and Worksharing (1 hour Core-Tier1, 1 hour Core-Tier2)	24									24
★	BIM/BIM Software Practicum (1 hour Core-Tier1, 1 hour Core-Tier2)	24									24
	Total	96	40	64	0	0	0	0	0	0	

Table 2.1: General Architecture topics by course 1st Semester

		Second Sem							Third Sem						.
	Knowledge Units of General Architecture **Courses →**	AR1B2	AR1D2	AR2R1	ID101	EG263	EG264	EG265	AR1D3	AR2B1	AR3R1	ID102	EG364	EG366	Total
★	ADG/Design Process and Creative Methods (1 hour Core-Tier1, 1 hour Core-Tier2)		10												10
★	ADG/Human-Centered and Inclusive Design (1 hour Core-Tier1, 1 hour Core-Tier2)		8						8						16
★	STR/Residential and Vernacular Structural Systems (1 hour Core-Tier1, 1 hour Core-Tier2)		8												8
★	STR/Lateral Load-Resisting Systems (1 hour Core-Tier1, 1 hour Core-Tier2)								10						10
★	ENV/Daylighting and Visual Comfort (1 hour Core-Tier1, 1 hour Core-Tier2)		8												8
★	ENV/Thermal Comfort and Passive Systems (1 hour Core-Tier1, 1 hour Core-Tier2)		8												8
★	UDP/Urban Form and Morphology (1 hour Core-Tier1, 1 hour Core-Tier2)								10						10
★	UDP/Housing and Residential Environments (1 hour Core-Tier1, 1 hour Core-Tier2)		12						12						24
★	UDP/Social Equity and Inclusive Urbanism (1 hour Core-Tier1, 1 hour Core-Tier2)								8						8
★	REP/Computer-Aided Drafting (CAD) (1 hour Core-Tier1, 1 hour Core-Tier2)			32											32
★	REP/Three-Dimensional Modeling (1 hour Core-Tier1, 1 hour Core-Tier2)										24				24
★	REP/Architectural Communication and Presentation (1 hour Core-Tier1, 1 hour Core-Tier2)		8								24				32
★	REP/Parametric Design and Visual Programming (1 hour Core-Tier1, 1 hour Core-Tier2)			32											32
★	REP/Simulation and Performance Analysis (1 hour Core-Tier1, 1 hour Core-Tier2)										24				24
	REP/Augmented, Virtual, and Mixed Reality (XR)										24				24
★	REP/Generative AI for Architectural Design (1 hour Core-Tier1, 1 hour Core-Tier2)			32											32
	REP/Digital Fabrication Output and CNC Toolpaths	24													24
★	BIM/Parametric Modeling and Visual Scripting for BIM (1 hour Core-Tier1, 1 hour Core-Tier2)	24													24
★	BIM/Multidisciplinary Model Coordination (1 hour Core-Tier1, 1 hour Core-Tier2)									24					24
★	BIM/Collaborative BIM Workflows (1 hour Core-Tier1, 1 hour Core-Tier2)									24					24

Knowledge Units of General Architecture Courses →	AR1T1	AR2B2	AR2D1	ID201	EG363	EG365	AR2B3	AR2D2	ID202	AR2D3	AR3B1	ID203	AR3B2	AR3D1	AR400	Total
ADG/Performance-Driven Design (1 hour Core-Tier1, 1 hour Core-Tier2)								10								10
ADG/Large-Scale and Complex Buildings										12						12
BTC/Building Systems and Assemblies (1 hour Core-Tier1, 1 hour Core-Tier2)			12							10						22
BTC/Facade and Building Envelope Technology (1 hour Core-Tier1, 1 hour Core-Tier2)								12								12
STR/Structural Principles and Mechanics (1 hour Core-Tier1, 1 hour Core-Tier2)			10													10
STR/Vertical Load Path and Foundations (1 hour Core-Tier1, 1 hour Core-Tier2)			10													10
STR/Long-Span and Special Structures (1 hour Core-Tier1, 1 hour Core-Tier2)								10								10
STR/Seismic Design for Architecture (1 hour Core-Tier1, 1 hour Core-Tier2)										10						10
ENV/Daylighting and Visual Comfort (1 hour Core-Tier1, 1 hour Core-Tier2)								8								8
ENV/Natural Ventilation and Indoor Air Quality (1 hour Core-Tier1, 1 hour Core-Tier2)			8													8
ENV/Mechanical Systems (HVAC) (1 hour Core-Tier1, 1 hour Core-Tier2)								8								8
ENV/Acoustics and Noise Control (1 hour Core-Tier1, 1 hour Core-Tier2)								8								8
UDP/Urban Form and Morphology (1 hour Core-Tier1, 1 hour Core-Tier2)														8		8
UDP/Contemporary Planning Methods and Theory (1 hour Core-Tier1, 1 hour Core-Tier2)														10		10
UDP/Urban Design at Multiple Scales (1 hour Core-Tier1, 1 hour Core-Tier2)														10		10
UDP/Landscape and Open Space Design (1 hour Core-Tier1, 1 hour Core-Tier2)														8		8
PRO/Project Management and Construction Economics (1 hour Core-Tier1, 1 hour Core-Tier2)										8						8
LAN/Landscape Design Principles and Process (1 hour Core-Tier1, 1 hour Core-Tier2)														10		10
LAN/Urban Landscape and Green Infrastructure (1 hour Core-Tier1, 1 hour Core-Tier2)														8		8

	Fourth Sem							Fifth Sem			Sixth Sem			Seventh Sem			
Knowledge Units of General Architecture Courses →	AR1T1	AR2B2	AR2D1	ID201	EG363	EG365	AR2B3	AR2D2	ID202	AR2D3	AR3B1	ID203	AR3B2	AR3D1	AR400	Total
★ BIM/5D BIM and Cost Estimation (1 hour Core-Tier1, 1 hour Core-Tier2)							24									24
★ BIM/BIM for Structural and MEP Coordination (1 hour Core-Tier1, 1 hour Core-Tier2)											24					24
★ BIM/BIM for Sustainability Analysis (1 hour Core-Tier1, 1 hour Core-Tier2)													24			24
★ BIM/BIM Execution Planning and Standards (1 hour Core-Tier1, 1 hour Core-Tier2)		24														24
★ BIM/BIM Standards, Policy, and Contracts (1 hour Core-Tier1, 1 hour Core-Tier2)		24														24
★ BIM/BIM Across Project Delivery Methods (1 hour Core-Tier1, 1 hour Core-Tier2)		24														24
★ BIM/Lean Construction and 4D BIM Integration (1 hour Core-Tier1, 1 hour Core-Tier2)							24									24
★ BIM/Fabrication-Level BIM Detailing (1 hour Core-Tier1, 1 hour Core-Tier2)											24					24
★ BIM/BIM Model Quality Control and Auditing (1 hour Core-Tier1, 1 hour Core-Tier2)											24					24
★ BIM/BIM for Circular Economy and Material Reuse (1 hour Core-Tier1, 1 hour Core-Tier2)													24			24
★ BIM/BIM-Supported Green Building Certification (1 hour Core-Tier1, 1 hour Core-Tier2)													24			24
★ BIM/BIM Software Practicum (1 hour Core-Tier1, 1 hour Core-Tier2)		24					24				24		24			96
Total	0	96	50	0	0	0	96	56	0	50	96	0	96	54	48	

Table 2.4: General Architecture topics by course from 4th to 7th Semester (Part 2 of 2)

		Eighth Sem			Ninth Sem			Tenth Sem				.
	Knowledge Units of General Architecture **Courses →**	AR3B3	AR3D2	AR401	AR3B4	AR3D3	AR402	AR3D4	AR403	AR404	AR4B1	Total
	ADG/Large-Scale and Complex Buildings		12			14		16				42
★	BTC/Building Systems and Assemblies (1 hour Core-Tier1, 1 hour Core-Tier2)					10		12				22
★	BTC/Circular and Recycled Materials (1 hour Core-Tier1, 1 hour Core-Tier2)		8									8
★	STR/Long-Span and Special Structures (1 hour Core-Tier1, 1 hour Core-Tier2)					12						12
★	ENV/Energy Efficiency and Net-Zero Design (1 hour Core-Tier1, 1 hour Core-Tier2)							10				10
★	UDP/Urban Design at Multiple Scales (1 hour Core-Tier1, 1 hour Core-Tier2)					10						10
	PRO/Business of Architecture and Entrepreneurship									16		16
★	HER/Theory and Philosophy of Conservation (1 hour Core-Tier1, 1 hour Core-Tier2)		8									8
★	HER/Historic Documentation and Digital Survey (1 hour Core-Tier1, 1 hour Core-Tier2)		8									8
★	HER/Structural Assessment of Historic Buildings (1 hour Core-Tier1, 1 hour Core-Tier2)		8									8
★	HER/Adaptive Reuse and Building Transformation (1 hour Core-Tier1, 1 hour Core-Tier2)		10									10
★	RED/Development Process and Feasibility (1 hour Core-Tier1, 1 hour Core-Tier2)					8				16		24
	RED/Stakeholder and Participatory Development									16		16
	RED/PropTech and Digital Real Estate Innovation									16		16
★	RES/Research Design and Methodologies (1 hour Core-Tier1, 1 hour Core-Tier2)						20					20
★	RES/Theoretical Framework and Literature Review (1 hour Core-Tier1, 1 hour Core-Tier2)						20					20
★	RES/Research Hypotheses and Variables (1 hour Core-Tier1, 1 hour Core-Tier2)			12			16					28
★	NRM/Building Codes, Accessibility, and Zoning (1 hour Core-Tier1, 1 hour Core-Tier2)							8				8
★	BIM/BIM Fundamentals and Authoring (1 hour Core-Tier1, 1 hour Core-Tier2)							5				5
★	BIM/BIM for Facilities Management (1 hour Core-Tier1, 1 hour Core-Tier2)	24										24
★	BIM/BIM Execution Planning and Standards (1 hour Core-Tier1, 1 hour Core-Tier2)							3				3
★	BIM/Heritage BIM (HBIM) (1 hour Core-Tier1, 1 hour Core-Tier2)				24							24
★	BIM/BIM for Infrastructure and Urban Modeling (1 hour Core-Tier1, 1 hour Core-Tier2)				24							24
★	BIM/AI-Assisted BIM Automation (1 hour Core-Tier1, 1 hour Core-Tier2)										24	24
★	BIM/Operational Digital Twins from BIM (1 hour Core-Tier1, 1 hour Core-Tier2)	24										24
★	BIM/Asset Classification and Data Standards for FM (1 hour Core-Tier1, 1 hour Core-Tier2)	24										24

Table 2.5: General Architecture topics by course from 8th to 10th Semester (Part 1 of 2)

		Eighth Sem			Ninth Sem			Tenth Sem				.
	Knowledge Units of General Architecture **Courses →**	AR3B3	AR3D2	AR401	AR3B4	AR3D3	AR402	AR3D4	AR403	AR404	AR4B1	Total
★	BIM/Reality Capture for BIM: Point Clouds and Photogrammetry (1 hour Core-Tier1, 1 hour Core-Tier2)				24							24
★	BIM/Integrated BIM Project Delivery (Capstone) (1 hour Core-Tier1, 1 hour Core-Tier2)										24	24
	BIM/Emerging Trends in BIM Practice										24	24
★	BIM/BIM Software Practicum (1 hour Core-Tier1, 1 hour Core-Tier2)	24			24						24	72
	Total	96	54	12	96	54	56	54	0	64	96	

Table 2.6: General Architecture topics by course from 8th to 10th Semester (Part 2 of 2)

2.3.2 Architectural Sciences topics/course

		First Sem									.
	Knowledge Units of Architectural Sciences **Courses →**	AR1B1	AR1D1	AR1R1	MA100	MA111	EG163	EG164	EG165	EG166	Total
★	CAN/Limits and Continuity (1 hour Core-Tier1, 1 hour Core-Tier2)					20					20
★	CAN/Differential Calculus (1 hour Core-Tier1, 1 hour Core-Tier2)					20					20
★	CAN/Integral Calculus (1 hour Core-Tier1, 1 hour Core-Tier2)					10					10
★	GTO/Euclidean and Projective Geometry (1 hour Core-Tier1, 1 hour Core-Tier2)			32							32
	Total	0	0	32	0	50	0	0	0	0	

Table 2.7: Architectural Sciences topics by course 1st Semester

		Second Sem							Third Sem						.
Knowledge Units of Architectural Sciences	**Courses →**	AR1B2	AR1D2	AR2R1	ID101	EG263	EG264	EG265	AR1D3	AR2B1	AR3R1	ID102	EG364	EG366	Total
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 2.8: Architectural Sciences topics by course from 2nd to 3rd Semester

		Fourth Sem						Fifth Sem			Sixth Sem			Seventh Sem			.
Knowledge Units of Architectural Sciences	**Courses →**	AR1T1	AR2B2	AR2D1	ID201	EG363	EG365	AR2B3	AR2D2	ID202	AR2D3	AR3B1	ID203	AR3B2	AR3D1	AR400	Total
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 2.9: Architectural Sciences topics by course from 4th to 7th Semester

		Eighth Sem			Ninth Sem			Tenth Sem				.
Knowledge Units of Architectural Sciences	**Courses →**	AR3B3	AR3D2	AR401	AR3B4	AR3D3	AR402	AR3D4	AR403	AR404	AR4B1	Total
★ DSC/Numerical Summaries: Location, Spread, and Shape (1 hour Core-Tier1, 1 hour Core-Tier2)				12								12
★ INF/Point Estimation (1 hour Core-Tier1, 1 hour Core-Tier2)				10								10
★ INF/Interval Estimation and Confidence Intervals (1 hour Core-Tier1, 1 hour Core-Tier2)				10								10
★ INF/Hypothesis Testing Foundations (1 hour Core-Tier1, 1 hour Core-Tier2)				10								10
★ REG/Simple Linear Regression (1 hour Core-Tier1, 1 hour Core-Tier2)				10								10
Total		0	0	52	0	0	0	0	0	0	0	

Table 2.10: Architectural Sciences topics by course from 8th to 10th Semester

2.3.3 Urbanism topics/course

Knowledge Units of Urbanism	Courses →	ARIB1	ARIDI	ARIRI	MA100	MA111	EG163	EG164	EG165	EG166	.
		First Sem									Total
Total		0	0	0	0	0	0	0	0	0	

Table 2.11: Urbanism topics by course 1st Semester

Knowledge Units of Urbanism	Courses →	ARIB2	ARIDI2	AR2RI	ID101	EG263	EG264	EG265	ARIDI3	AR2BI	AR3RI	ID102	EG364	EG366	.
		Second Sem							Third Sem						
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 2.12: Urbanism topics by course from 2nd to 3rd Semester

					Fourth Sem					Fifth Sem			Sixth Sem			Seventh Sem		.
	Knowledge Units of Urbanism **Courses →**	AR1T1	AR2B2	AR2D1	ID201	EG363	EG365	AR2B3	AR2D2	ID202	AR2D3	AR3B1	ID203	AR3B2	AR3D1	AR400	Total
⭐	TAN/Territorial Concepts, Scales, and Spatial Reference (1 hour Core-Tier1, 1 hour Core-Tier2)	20															20
⭐	TAN/Cartography and Spatial Representation (1 hour Core-Tier1, 1 hour Core-Tier2)	20															20
⭐	TAN/Geographic Information Systems (1 hour Core-Tier1, 1 hour Core-Tier2)	20															20
⭐	TAN/Remote Sensing and Earth Observation (1 hour Core-Tier1, 1 hour Core-Tier2)	20															20
	Total	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 2.13: Urbanism topics by course from 4th to 7th Semester

				Eighth Sem			Ninth Sem			Tenth Sem				.
Knowledge Units of Urbanism	**Courses →**	AR3B3	AR3D2	AR401	AR3B4	AR3D3	AR402	AR3D4	AR403	AR404	AR4B1	Total
Total		0	0	0	0	0	0	0	0	0	0	

Table 2.14: Urbanism topics by course from 8th to 10th Semester

2.3.4 Project Management topics/course

First Sem										
Knowledge Units of Project Management	Courses →	AR1B1	AR1D1	AR1R1	MA100	MA111	EG163	EG164	EG165	EG166	Total
Total		0	0	0	0	0	0	0	0	0	0

Table 2.15: Project Management topics by course 1st Semester

Second Sem										Third Sem										
Knowledge Units of Project Management	Courses →	AR1B2	AR1D2	AR2R1	ID101	EG263	EG264	EG265		AR1D3	AR2B1	AR3R1	ID102	EG364	EG366					Total
Total		0	0	0	0	0	0	0		0	0	0	0	0	0					0

Table 2.16: Project Management topics by course from 2nd to 3rd Semester

Fourth Sem									Fifth Sem						Sixth Sem					Seventh Sem		
Knowledge Units of Project Management	Courses →	AR1T1	AR2B2	AR2D1	ID201	EG363	EG365		AR2B3	AR2D2	ID202				AR3B1	AR2D3	ID203			AR3B2	AR3D1	AR400	Total
Total		0	0	0	0	0	0		0	0	0				0	0	0			0	0	0	0

Table 2.17: Project Management topics by course from 4th to 7th Semester

		Eighth Sem			Ninth Sem			Tenth Sem			
Knowledge Units of Project Management	**Courses →**	AR3B3	AR3D2	AR401	AR3B4	AR3D3	AR402	AR3D4	AR403	AR404	AR4B1	Total
Total		0	0	0	0	0	0	0	0	0	0	

Table 2.18: Project Management topics by course from 8th to 10th Semester

2.4 Expected outcomes distributed by course

The following tables provide an overview of the outcomes expected to be achieved in each course of the present curriculum. The complete list of expected outcomes can be found in Section: 1.6.1.

25

First Sem								
Skill/Course	ARIBI	ARIDI	ARIRI	MAI00	MAI11	EGI63	EGI64	EGI65	EGI66
AG-A01) Evaluates the impact of architecture.									
AG-A02) Applies ethics and respect for diversity.									
AG-A03) Works effectively in multidisciplinary teams.	2								
AG-A04) Communicates effectively through reports and presentations.	2	2	3			2			
AG-A05) Manages projects with economic judgment.							2	2	
AG-A06) Learns continuously and adapts to new technology.	2								2
AG-A07) Applies science and technology to architectural solutions.			3	1	1		2		
AG-A08) Understands structural and environmental design problems.									
AG-A09) Creates aesthetic and technically sound designs.		2							
AG-A10) Conducts studies using research methods.								1	
AG-A11) Designs buildings for environmental comfort.									
AG-A12) Designs within cost and regulatory constraints.									
AG-A13) Designs with ecological and environmental responsibility.									
AG-A14) Applies creativity in construction techniques.									
AG-A15) Understands the relationship between people, buildings, and environment.									

Table 2.19: Outcomes by course 1st Semester

		Second Sem							Third Sem					
	Skill/Course	AR1B2	AR1D2	AR2R1	ID101	EG263	EG264	EG265	AR1D3	AR2B1	AR3R1	ID102	EG364	EG366
AG-A01)	Evaluates the impact of architecture.						1	2						
AG-A02)	Applies ethics and respect for diversity.						1	1	2				3	
AG-A03)	Works effectively in multidisciplinary teams.									2				2
AG-A04)	Communicates effectively through reports and presentations.		2	3	2	3				2	3	2		
AG-A05)	Manages projects with economic judgment.												2	
AG-A06)	Learns continuously and adapts to new technology.	2		3						2	3			
AG-A07)	Applies science and technology to architectural solutions.	2												
AG-A08)	Understands structural and environmental design problems.		2						2					
AG-A09)	Creates aesthetic and technically sound designs.	2												
AG-A10)	Conducts studies using research methods.					2								
AG-A11)	Designs buildings for environmental comfort.		2											
AG-A12)	Designs within cost and regulatory constraints.													
AG-A13)	Designs with ecological and environmental responsibility.													
AG-A14)	Applies creativity in construction techniques.													
AG-A15)	Understands the relationship between people, buildings, and environment.		2						2					

Table 2.20: Outcomes by course 2nd to 3rd Semester

		Fourth Sem						Fifth Sem			Sixth Sem			Seventh Sem		
	Skill/Course	AR1T1	AR2B2	AR2D1	ID201	EG363	EG365	AR2B3	AR2D2	ID202	AR2D3	AR3B1	ID203	AR3B2	AR3D1	AR400
AG-A01)	Evaluates the impact of architecture.					2	2								2	
AG-A02)	Applies ethics and respect for diversity.		2													
AG-A03)	Works effectively in multidisciplinary teams.															
AG-A04)	Communicates effectively through reports and presentations.				2					2			2			3
AG-A05)	Manages projects with economic judgment.		2					2			2					
AG-A06)	Learns continuously and adapts to new technology.	3	2					2				2		2		
AG-A07)	Applies science and technology to architectural solutions.	3														
AG-A08)	Understands structural and environmental design problems.			2					2			2				
AG-A09)	Creates aesthetic and technically sound designs.										2					
AG-A10)	Conducts studies using research methods.															3
AG-A11)	Designs buildings for environmental comfort.								2							
AG-A12)	Designs within cost and regulatory constraints.			2							2			2		
AG-A13)	Designs with ecological and environmental responsibility.					2								2	2	
AG-A14)	Applies creativity in construction techniques.			2				2	2			2				
AG-A15)	Understands the relationship between people, buildings, and environment.														2	

Table 2.21: Outcomes by course 4th to 7th Semester

		Eighth Sem			Ninth Sem				Tenth Sem		
	Skill/Course	AR3B3	AR3D2	AR401	AR3B4	AR3D3	AR402	AR3D4	AR403	AR404	AR4B1
AG-A01)	Evaluates the impact of architecture.		2		2						
AG-A02)	Applies ethics and respect for diversity.										
AG-A03)	Works effectively in multidisciplinary teams.										
AG-A04)	Communicates effectively through reports and presentations.						3		3		3
AG-A05)	Manages projects with economic judgment.	2								3	3
AG-A06)	Learns continuously and adapts to new technology.	2			2					3	3
AG-A07)	Applies science and technology to architectural solutions.			3	2						3
AG-A08)	Understands structural and environmental design problems.					2					
AG-A09)	Creates aesthetic and technically sound designs.					2		2			
AG-A10)	Conducts studies using research methods.		2	3			3		3		
AG-A11)	Designs buildings for environmental comfort.										
AG-A12)	Designs within cost and regulatory constraints.					2		2			
AG-A13)	Designs with ecological and environmental responsibility.							2			
AG-A14)	Applies creativity in construction techniques.		2								
AG-A15)	Understands the relationship between people, buildings, and environment.										

Table 2.22: Outcomes by course 8^{th} to 10^{th} Semester

2.5 Courses by Outcome

2.5.1 Outcome: AG-A01) Evaluates the impact of architecture.

- EG264 Philosophy (2nd Sem-Pg. 86)
- EG265 Peruvian Territory. National Defense and Security (2nd Sem-Pg. 89)
- EG363 Ecology and Sustainable Development (4th Sem-Pg. 127)
- EG365 Peru's Problems and Challenges in a Global World (4th Sem-Pg. 130)
- AR3D1 Design Studio VII (7th Sem-Pg. 159)
- AR3D2 Design Studio VIII (8th Sem-Pg. 170)
- AR3B4 Heritage and Infrastructure (9th Sem-Pg. 178)

2.5.2 Outcome: AG-A02) Applies ethics and respect for diversity.

- EG264 Philosophy (2nd Sem-Pg. 86)
- EG265 Peruvian Territory. National Defense and Security (2nd Sem-Pg. 89)
- AR1D3 Design Studio III (3rd Sem-Pg. 92)
- EG364 Ethics (3rd Sem-Pg. 107)
- AR2B2 BIM Execution Planning (4th Sem-Pg. 116)

2.5.3 Outcome: AG-A03) Works effectively in multidisciplinary teams.

- AR1B1 Introduction to BIM (1st Sem-Pg. 41)
- AR2B1 Multidisciplinary Coordination (3rd Sem-Pg. 96)
- EG366 Personal Development and Leadership (3rd Sem-Pg. 110)

2.5.4 Outcome: AG-A04) Communicates effectively through reports and presentations.

- AR1B1 Introduction to BIM (1st Sem-Pg. 41)
- AR1D1 Design Studio I (1st Sem-Pg. 45)
- AR1R1 Geometry and Analog Drawing (1st Sem-Pg. 49)
- EG163 Communication I (1st Sem-Pg. 56)
- AR1D2 Design Studio II (2nd Sem-Pg. 72)
- AR2R1 Digital Drafting (2nd Sem-Pg. 77)
- ID101 Technical and professional English I (2nd Sem-Pg. 80)
- EG263 Communication II (2nd Sem-Pg. 83)
- AR2B1 Multidisciplinary Coordination (3rd Sem-Pg. 96)
- AR3R1 3D Modeling and Virtual Animation (3rd Sem-Pg. 99)
- ID102 Technical and professional English II (3rd Sem-Pg. 103)
- ID201 Technical and professional English III (4th Sem-Pg. 123)
- ID202 Technical and professional English IV (5th Sem-Pg. 141)
- ID203 Technical and professional English V (6th Sem-Pg. 152)
- AR400 Scientific Research Methodology (7th Sem-Pg. 163)
- AR402 Research Workshop (9th Sem-Pg. 186)
- AR403 Research Work (10th Sem-Pg. 194)
- AR4B1 AI-Assisted Automation (10th Sem-Pg. 199)

2.5.5 Outcome: AG-A05) Manages projects with economic judgment.

- EG364 Ethics (3rd Sem-Pg. 107)
- AR2B2 BIM Execution Planning (4th Sem-Pg. 116)

- AR2B3 BIM Scheduling and Cost (5th Sem-Pg. 133)
- AR2D3 Design Studio VI (6th Sem-Pg. 145)
- AR3B3 Facilities Management (8th Sem-Pg. 167)
- AR404 Innovation and Entrepreneurship (10th Sem-Pg. 196)
- AR4B1 AI-Assisted Automation (10th Sem-Pg. 199)

2.5.6 Outcome: AG-A06) Learns continuously and adapts to new technology.

- AR1B1 Introduction to BIM (1st Sem-Pg. 41)
- EG164 Digital Competencies Development (1st Sem-Pg. 59)
- EG165 Strategies for Autonomous Learning (1st Sem-Pg. 62)
- AR1B2 Parametric Modeling and Generative Design (2nd Sem-Pg. 68)
- AR2R1 Digital Drafting (2nd Sem-Pg. 77)
- AR2B1 Multidisciplinary Coordination (3rd Sem-Pg. 96)
- AR3R1 3D Modeling and Virtual Animation (3rd Sem-Pg. 99)
- AR1T1 Digital Topography (4th Sem-Pg. 113)
- AR2B2 BIM Execution Planning (4th Sem-Pg. 116)
- AR2B3 BIM Scheduling and Cost (5th Sem-Pg. 133)
- AR3B1 Structural and MEP Coordination (6th Sem-Pg. 149)
- AR3B2 Sustainability and Circular Economy (7th Sem-Pg. 156)
- AR3B3 Facilities Management (8th Sem-Pg. 167)
- AR3B4 Heritage and Infrastructure (9th Sem-Pg. 178)
- AR404 Innovation and Entrepreneurship (10th Sem-Pg. 196)
- AR4B1 AI-Assisted Automation (10th Sem-Pg. 199)

2.5.7 Outcome: AG-A07) Applies science and technology to architectural solutions.

- AR1R1 Geometry and Analog Drawing (1st Sem-Pg. 49)
- MA100 Basic Mathematics (1st Sem-Pg. 52)
- MA111 Calculus I (1st Sem-Pg. 54)
- EG164 Digital Competencies Development (1st Sem-Pg. 59)
- EG166 Basic Mathematics (1st Sem-Pg. 65)
- AR1B2 Parametric Modeling and Generative Design (2nd Sem-Pg. 68)
- AR1T1 Digital Topography (4th Sem-Pg. 113)
- AR401 Statistics and Research Instruments (8th Sem-Pg. 174)
- AR3B4 Heritage and Infrastructure (9th Sem-Pg. 178)
- AR4B1 AI-Assisted Automation (10th Sem-Pg. 199)

2.5.8 Outcome: AG-A08) Understands structural and environmental design problems.

- AR1D2 Design Studio II (2nd Sem-Pg. 72)
- AR1D3 Design Studio III (3rd Sem-Pg. 92)
- AR2D1 Design Studio IV (4th Sem-Pg. 119)
- AR2D2 Design Studio V (5th Sem-Pg. 136)
- AR3B1 Structural and MEP Coordination (6th Sem-Pg. 149)
- AR3D3 Design Studio IX (9th Sem-Pg. 182)

2.5.9 Outcome: AG-A09) Creates aesthetic and technically sound designs.

- AR1D1 Design Studio I (1st Sem-Pg. 45)

- AR1B2 Parametric Modeling and Generative Design (2nd Sem-Pg. 68)
- AR2D3 Design Studio VI (6th Sem-Pg. 145)
- AR3D3 Design Studio IX (9th Sem-Pg. 182)
- AR3D4 Design Studio X (10th Sem-Pg. 189)

2.5.10 Outcome: AG-A10) Conducts studies using research methods.

- EG165 Strategies for Autonomous Learning (1st Sem-Pg. 62)
- EG263 Communication II (2nd Sem-Pg. 83)
- AR400 Scientific Research Methodology (7th Sem-Pg. 163)
- AR3D2 Design Studio VIII (8th Sem-Pg. 170)
- AR401 Statistics and Research Instruments (8th Sem-Pg. 174)
- AR402 Research Workshop (9th Sem-Pg. 186)
- AR403 Research Work (10th Sem-Pg. 194)

2.5.11 Outcome: AG-A11) Designs buildings for environmental comfort.

- AR1D2 Design Studio II (2nd Sem-Pg. 72)
- AR2D2 Design Studio V (5th Sem-Pg. 136)

2.5.12 Outcome: AG-A12) Designs within cost and regulatory constraints.

- AR2D1 Design Studio IV (4th Sem-Pg. 119)
- AR2D3 Design Studio VI (6th Sem-Pg. 145)
- AR3B2 Sustainability and Circular Economy (7th Sem-Pg. 156)
- AR3D3 Design Studio IX (9th Sem-Pg. 182)
- AR3D4 Design Studio X (10th Sem-Pg. 189)

2.5.13 Outcome: AG-A13) Designs with ecological and environmental responsibility.

- EG363 Ecology and Sustainable Development (4th Sem-Pg. 127)
- AR3B2 Sustainability and Circular Economy (7th Sem-Pg. 156)
- AR3D1 Design Studio VII (7th Sem-Pg. 159)
- AR3D4 Design Studio X (10th Sem-Pg. 189)

2.5.14 Outcome: AG-A14) Applies creativity in construction techniques.

- AR2D1 Design Studio IV (4th Sem-Pg. 119)
- AR2B3 BIM Scheduling and Cost (5th Sem-Pg. 133)
- AR2D2 Design Studio V (5th Sem-Pg. 136)
- AR3B1 Structural and MEP Coordination (6th Sem-Pg. 149)
- AR3D2 Design Studio VIII (8th Sem-Pg. 170)

2.5.15 Outcome: AG-A15) Understands the relationship between people, buildings, and environment.

- AR1D2 Design Studio II (2nd Sem-Pg. 72)
- AR1D3 Design Studio III (3rd Sem-Pg. 92)
- AR3D1 Design Studio VII (7th Sem-Pg. 159)

2.6 Course distribution in the Career

This proposal can be analyzed by the number of credits dedicated to each area, by course levels (Introductory, Intermediate, Advanced, and Projects).

	Mandatory			Elective			
	General Studies	Specific	Sz*	General Studies	Specific	Sz*	Total
1st Sem	48	24					72
2nd Sem	22	24					46
3rd Sem	16	24					40
4th Sem	16	22					38
5th Sem	4	16					20
6th Sem	4	16					20
7th Sem		16	6				22
8th Sem		16	6				22
9th Sem		16	8				24
10th Sem		16	16				32
Total	110	190	36	0	0	0	**336**

Sz* = Specialization

Table 2.23: Distribution of credits by area by semester

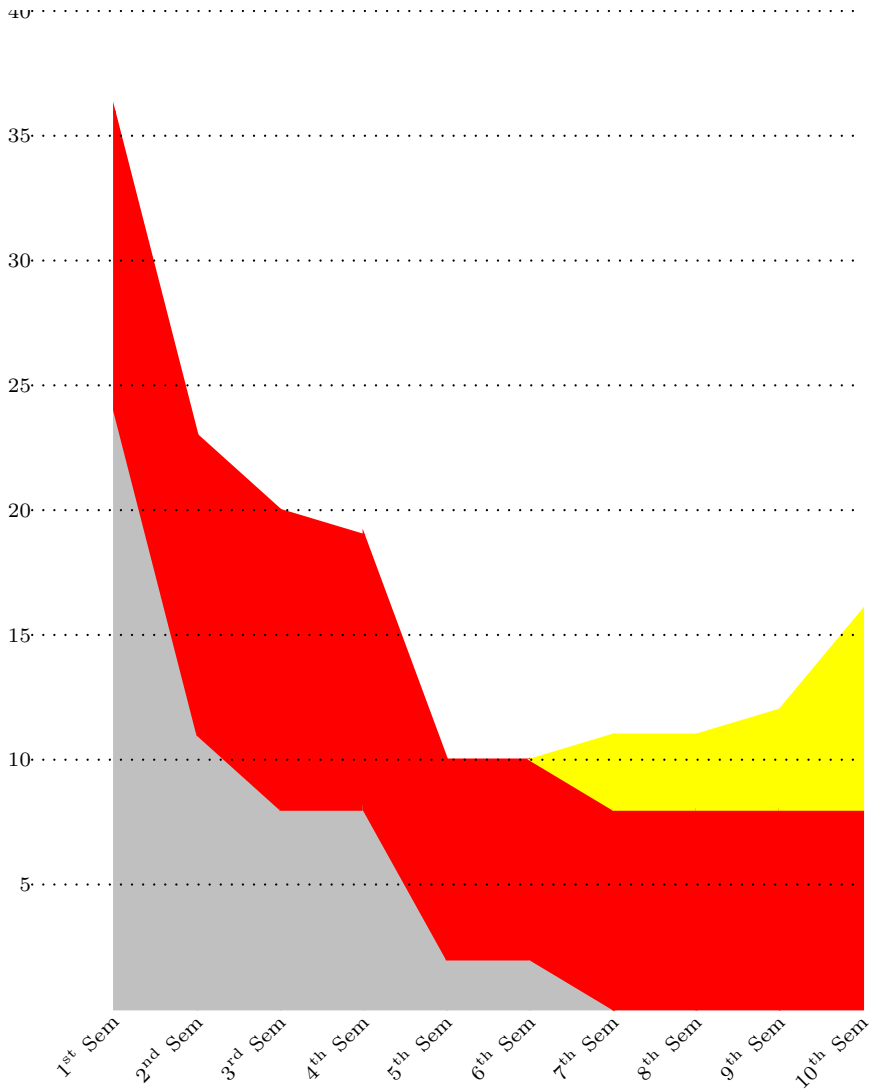


Figure 2.2: Credits by area by semester

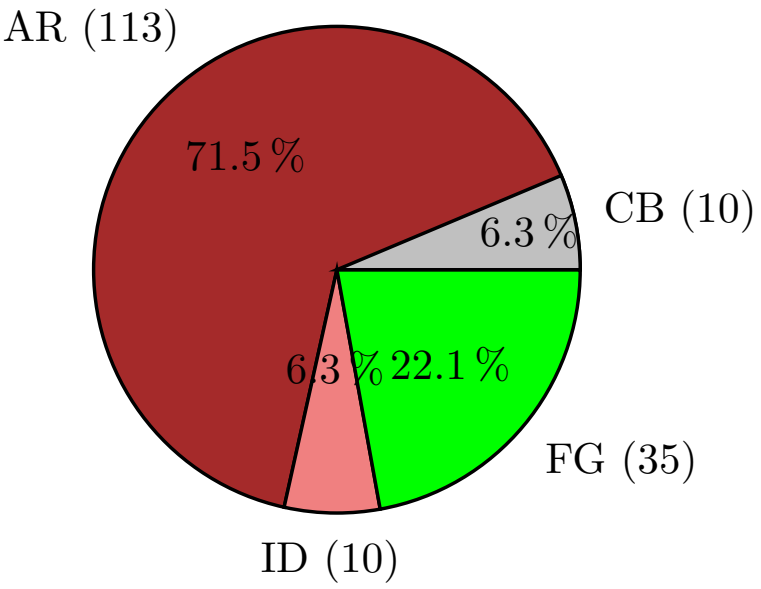


Figure 2.3: Distribution of courses by area considering credits.

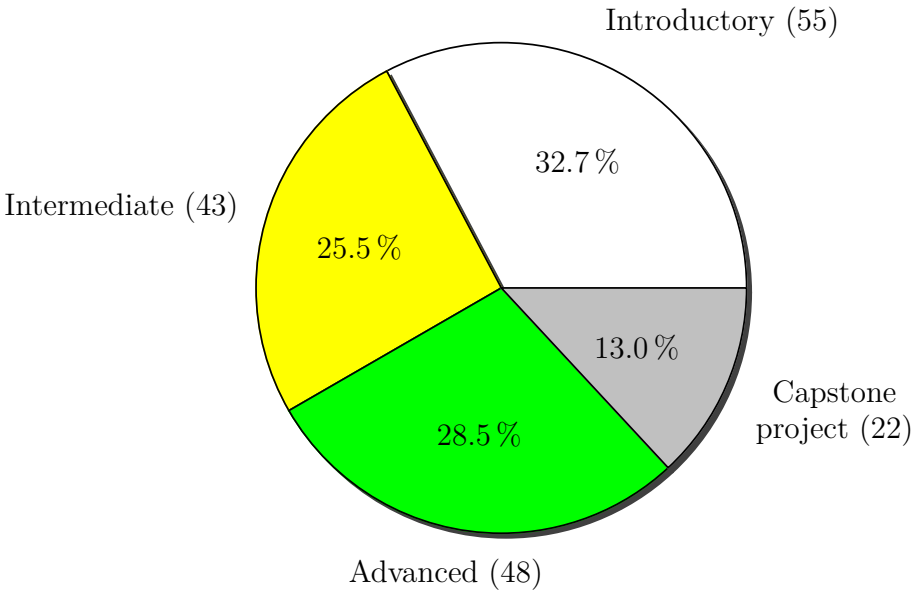


Figure 2.4: Distribution of credits by course levels.

2.7 Departments

2.7.1 BasicSciences

The list of courses for this department is:

- ID101 Technical and professional English I (2nd Sem)
- ID102 Technical and professional English II (3rd Sem)
- ID201 Technical and professional English III (4th Sem)
- ID202 Technical and professional English IV (5th Sem)
- ID203 Technical and professional English V (6th Sem)

2.7.2 DCB

The list of courses for this department is:

- MA100 Basic Mathematics (1st Sem)
- MA111 Calculus I (1st Sem)

2.8 Compatibility of the Career with International Standards

In this section, we present the distribution of courses by concentration areas in contrast to the international accreditation framework of ICACIT (Canberra Accord) for Architecture programs.

It is necessary to note that in some cases, courses may appear in more than one axis as they have content from more than one area. For example, a sustainability-focused design studio may contain units classifiable under Environmental Systems but at the same time contain fundamentals of Architectural Design, which belongs to a different axis. In these cases, the credits have been divided between the corresponding axes.

1. Architectural Design (160.00 Créditos)
   - AR1B1 Introduction to BIM (1st Sem-Pg. 41)
   - AR1D1 Design Studio I (1st Sem-Pg. 45)
   - AR1B2 Parametric Modeling and Generative Design (2nd Sem-Pg. 68)
   - AR1D2 Design Studio II (2nd Sem-Pg. 72)
   - AR1D3 Design Studio III (3rd Sem-Pg. 92)
   - AR2B1 Multidisciplinary Coordination (3rd Sem-Pg. 96)
   - AR2B2 BIM Execution Planning (4th Sem-Pg. 116)
   - AR2D1 Design Studio IV (4th Sem-Pg. 119)
   - AR2B3 BIM Scheduling and Cost (5th Sem-Pg. 133)
   - AR2D2 Design Studio V (5th Sem-Pg. 136)
   - AR2D3 Design Studio VI (6th Sem-Pg. 145)
   - AR3B1 Structural and MEP Coordination (6th Sem-Pg. 149)
   - AR3B2 Sustainability and Circular Economy (7th Sem-Pg. 156)
   - AR3D1 Design Studio VII (7th Sem-Pg. 159)
   - AR3B3 Facilities Management (8th Sem-Pg. 167)
   - AR3D2 Design Studio VIII (8th Sem-Pg. 170)
   - AR3B4 Heritage and Infrastructure (9th Sem-Pg. 178)
   - AR3D3 Design Studio IX (9th Sem-Pg. 182)
   - AR3D4 Design Studio X (10th Sem-Pg. 189)
   - AR4B1 AI-Assisted Automation (10th Sem-Pg. 199)
2. History and Theory
   - Ninguno
3. Construction and Technology
   - Ninguno
4. Urbanism (6.00 Créditos)
   - AR1T1 Digital Topography (4th Sem-Pg. 113)
5. Representation (24.00 Créditos)
   - AR1R1 Geometry and Analog Drawing (1st Sem-Pg. 49)
   - AR2R1 Digital Drafting (2nd Sem-Pg. 77)
   - AR3R1 3D Modeling and Virtual Animation (3rd Sem-Pg. 99)
6. Research (36.00 Créditos)
   - AR400 Scientific Research Methodology (7th Sem-Pg. 163)
   - AR401 Statistics and Research Instruments (8th Sem-Pg. 174)
   - AR402 Research Workshop (9th Sem-Pg. 186)
   - AR403 Research Work (10th Sem-Pg. 194)

- AR404 Innovation and Entrepreneurship (10th Sem-Pg. 196)

7. Professional Practice
   - Ninguno
8. Basic Sciences (20.00 Créditos)
   - MA100 Basic Mathematics (1st Sem-Pg. 52)
   - MA111 Calculus I (1st Sem-Pg. 54)
9. General Studies (90.00 Créditos)
   - EG163 Communication I (1st Sem-Pg. 56)
   - EG164 Digital Competencies Development (1st Sem-Pg. 59)
   - EG165 Strategies for Autonomous Learning (1st Sem-Pg. 62)
   - EG166 Basic Mathematics (1st Sem-Pg. 65)
   - ID101 Technical and professional English I (2nd Sem-Pg. 80)
   - EG263 Communication II (2nd Sem-Pg. 83)
   - EG264 Philosophy (2nd Sem-Pg. 86)
   - EG265 Peruvian Territory. National Defense and Security (2nd Sem-Pg. 89)
   - ID102 Technical and professional English II (3rd Sem-Pg. 103)
   - EG364 Ethics (3rd Sem-Pg. 107)
   - EG366 Personal Development and Leadership (3rd Sem-Pg. 110)
   - ID201 Technical and professional English III (4th Sem-Pg. 123)
   - EG363 Ecology and Sustainable Development (4th Sem-Pg. 127)
   - EG365 Peru's Problems and Challenges in a Global World (4th Sem-Pg. 130)
   - ID202 Technical and professional English IV (5th Sem-Pg. 141)
   - ID203 Technical and professional English V (6th Sem-Pg. 152)

2.9 Teaching guidelines

The teaching of architecture is organized around the **design studio**, a pedagogical space in which the student develops real or simulated projects under the instructor's continuous review and critique, simultaneously integrating technical knowledge, aesthetic judgment, and regulatory constraints. This format is complemented by active-learning strategies: problem-based learning (PBL), the case-study method applied to built works, interdisciplinary formative projects, teamwork, and the use of a portfolio as a tool for tracking each student's individual progress throughout the curriculum.

Project-critique sessions (desk crits and jury reviews) are a distinctive didactic component of the discipline, since they train students to argue their design decisions –orally and graphically– before a technical audience, a skill central to professional practice. These strategies are further supported by the institutional Virtual Classroom for managing forums, debates, and complementary resources outside studio hours.

In every case, the aim is to establish a relational, affective, and emotional climate built on trust and mutual respect, one that makes room for curiosity, the capacity to be surprised, and genuine interest in the design and construction of the built environment.

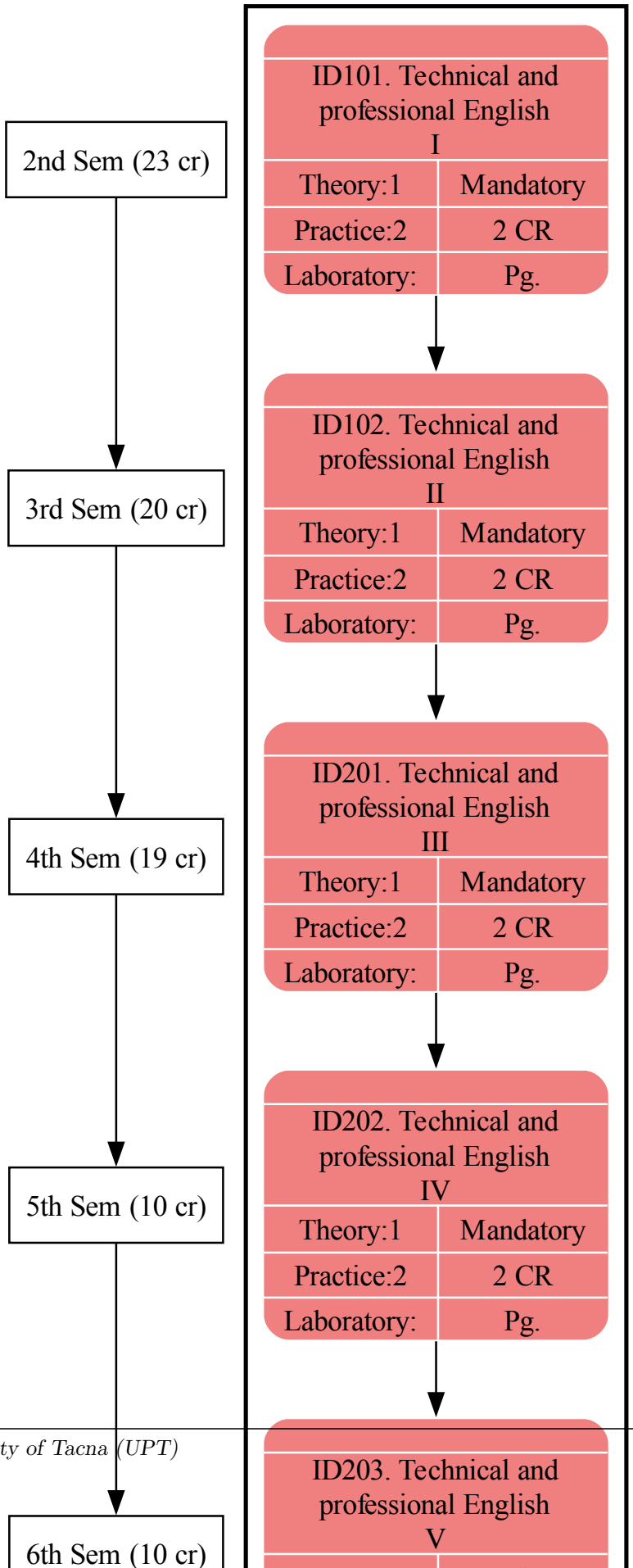
2.10 Evaluation system

Learning assessment at Universidad Privada de Tacna (UPT) is governed by the current Enrollment, Studies, and Evaluation Regulations, which define academic evaluation as a systematic, continuous, and ongoing process of an integral nature, which provides, obtains, processes, and interprets objective and useful information for decisions on student learning and promotion.

In the specific context of the design studio, evaluation combines instruments of different kinds: progressive review of project milestones (partial deliverables), oral and graphic defense before a jury, performance rubrics aligned to each course's learning outcomes (RA), and peer evaluation when the course format allows it. These instruments are chosen so that they relate closely to the activities carried out throughout the academic period, ensuring that evaluation is consistent with the integral nature

–conceptual, procedural, and attitudinal– of the competencies being developed, and that together they guarantee fulfillment of the graduate profile stated in this document.

Referencias Bibliográficas


2nd Sem (23 cr)
3rd Sem (20 cr)
4th Sem (19 cr)
5th Sem (10 cr)
6th Sem (10 cr)
ID101. Technical and professional English I
Theory:1
Mandatory
Practice:2
2 CR
Laboratory:
Pg.
ID102. Technical and professional English II
Theory:1
Mandatory
Practice:2
2 CR
Laboratory:
Pg.
ID201. Technical and professional English III
Theory:1
Mandatory
Practice:2
2 CR
Laboratory:
Pg.
ID202. Technical and professional English IV
Theory:1
Mandatory
Practice:2
2 CR
Laboratory:
Pg.
ID203. Technical and professional English V

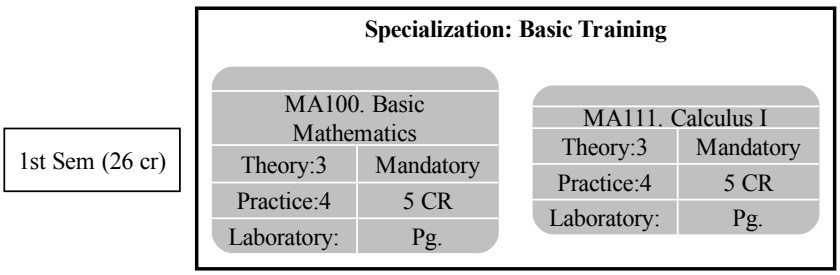


Figure 2.6: DCB

Chapter 3

Detailed content by course

First Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1B1 Introduction to BIM (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

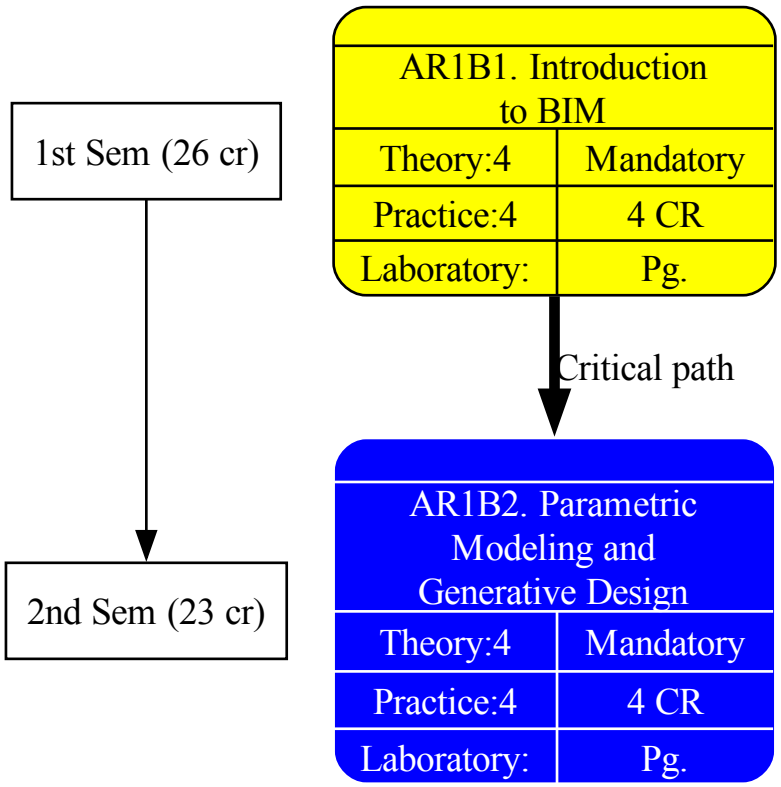


Figure 3.1: Connection Map. AR1B1 Introduction to BIM

2. Course Rationale

Introduction to BIM opens the ten-course BIM I-X sequence (AR1B1 to AR4B1) that runs obligatorily alongside the Design Studio and Representation lines across the whole program. As the first course in the sequence, it has no prerequisite: it introduces students to Building Information Modeling as an object-based, data-centric way of working, teaches them to produce a complete construction documentation set directly from a BIM model instead of drafting it separately, and establishes the file-organization and worksharing habits that every later, team-based BIM course in the sequence depends on. The course's transversal Practicum unit – a hands-on software-lab component that recurs, unchanged in structure, across all ten courses of the sequence – gives students graded, guided exercises in the authoring tool itself, building the baseline software fluency the rest of the sequence (coordination, scheduling, cost estimation, structural and MEP integration) will build upon.

3. Goals of the Course

- Explain and apply the foundational concepts of Building Information Modeling – object-based parametric modeling, authoring tools, level of development (LOD), and open data exchange – by building a simple BIM model and exporting it to IFC.
- Produce a complete, model-derived construction documentation set (sheets, views, schedules, and model-linked annotations) ready for permit submission.
- Organize a BIM project file for team-based production, applying naming conventions, worksets, and linked models, and resolve a basic worksharing conflict.

- Build hands-on proficiency in a BIM authoring tool through a sequence of guided, graded practicum exercises culminating in a cumulative deliverable.

4. General Competences (*Outcomes*)

AG-A03) Performs effectively as an individual and as a member or leader in diverse, inclusive teams, in multidisciplinary in-person and remote environments. (Usage)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

5. Content

5.1 BIM Fundamentals and Authoring, 24 hr(s)

Competences: AG-A06

Topics: **I:** Core BIM concepts: object-oriented modeling (walls, doors, windows with embedded data), parametric relationships (hosting, constraints), and the difference between BIM and conventional 2D/3D modeling **II:** BIM authoring tools: Revit (project-based, family editor), ArchiCAD (virtual building model), Vectorworks, and their respective modeling philosophies and interoperability **III:** Level of development (LOD) specification: LOD 100 (conceptual), 200 (schematic), 300 (detailed), 350 (construction-ready), 400 (fabrication), 500 (as-built) **IV:** Data exchange standards: Industry Foundation Classes (IFC) as openBIM exchange format, IFC schema (IfcWall, IfcDoor, IfcWindow, IfcSpace), and vendor-neutral model interoperability

Learning Outcomes **I:** Describe the core concepts of BIM: object-based modeling, parametric relationships, LOD, and data exchange via IFC, and explain how BIM differs from traditional 2D CAD [Familiarity] **II:** Develop a BIM model of a small building at LOD 200-300, producing plans, sections, elevations, and a simple schedule directly from the model, and export the model to IFC format [Usage] **III:** Evaluate a BIM model for appropriate LOD, correct parametric relationships, and clean IFC export, identifying modeling errors that would impede downstream coordination or data exchange [Assessment]

Bibliography: [Eastman et al., 2011]

5.2 BIM-Based Construction Documentation, 24 hr(s)

Competences: AG-A04

Topics: **I:** Sheet and view setup from the model: plan, section, elevation, and detail views generated directly from the BIM model, view templates, and view-specific graphic overrides **II:** Automated schedule generation: door, window, room finish, and area schedules extracted live from model data, and their coordination with drawing sheets **III:** Model-based annotation and tagging: dimension strings, keynotes, and tags linked to model elements so they update automatically when the model changes **IV:** Export formats for documentation delivery: PDF sets, DWG export for consultants without BIM authoring tools, and print/plot configuration for a full drawing set

Learning Outcomes **I:** Describe how a construction documentation set (plans, sections, elevations, schedules) is produced directly from a BIM model rather than drawn separately [Familiarity] **II:** Produce a coordinated set of sheets, views, and schedules from a BIM model, keeping annotations and tags linked to model elements [Usage] **III:** Evaluate a model-derived documentation set for completeness, internal consistency, and readiness for permit submission or construction [Assessment]

Bibliography: [Stine, 2021]

5.3 BIM Model Organization and Worksharing, 24 hr(s)

Competences: AG-A03

Topics: I: Project templates and file structure: starting templates, worksets, linked vs. inserted models, and project browser organization **II:** Naming and numbering conventions for models, sheets, and views, aligned with a project's BIM Execution Plan **III:** Worksharing mechanics: central/local file models, element ownership and borrowing, sync-with-central workflow, and conflict resolution between team members

Learning Outcomes I: Describe how a BIM project file is structured into worksets, links, and templates, and how multiple team members edit it concurrently through worksharing [Familiarity] **II:** Set up a BIM project's worksets, naming conventions, and linked models for a multi-person team, and resolve a worksharing conflict [Usage] **III:** Evaluate a BIM project's file organization and worksharing setup for consistency with its naming conventions and its ability to support concurrent editing [Assessment]

Bibliography: [Hardin and McCool, 2015]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: I: Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes I: Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Krygiel and Demchak, 2015]

6. Bibliography

[Eastman et al., 2011] Eastman, C., Teicholz, P., Sacks, R., and Liston, K. (2011). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors*. Wiley, 2nd edition.

[Hardin and McCool, 2015] Hardin, B. and McCool, D. (2015). *BIM and Construction Management: Proven Tools, Methods, and Workflows*. Wiley, 2nd edition.

[Krygiel and Demchak, 2015] Krygiel, E. and Demchak, G. (2015). *Mastering Autodesk Revit Architecture 2016*. Sybex, 1st edition.

[Stine, 2021] Stine, D. J. (2021). *Autodesk Revit 2022 for Architecture*. SDC Publications, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1D1 Design Studio I (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

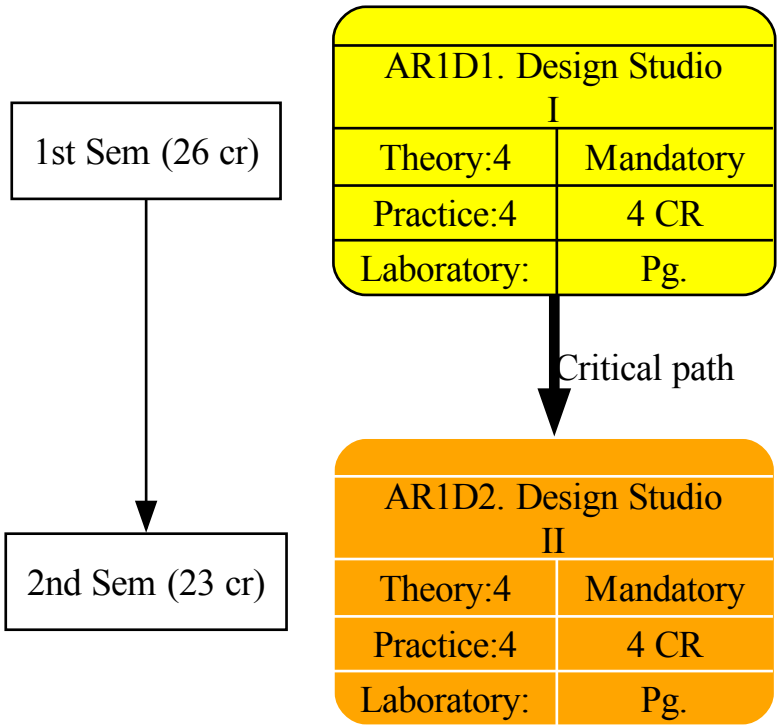


Figure 3.2: Connection Map. AR1D1 Design Studio I

2. Course Rationale

Design Studio I: Foundations is the student's first encounter with the studio culture that defines architectural education: short, intensive design exercises, physical model-making, pin-up and desk-crit critique, and iterative revision. Starting from purely abstract explorations of space, form, and light, the course progressively scales up these operations into the student's first habitable proposal – a minimal pavilion or similar small object-to-space exercise – while introducing the orthographic and three-dimensional drawing conventions needed to communicate spatial ideas. This course has no prerequisite within the Design Studio sequence and is the foundation for Design Studio II (AR1D2).

3. Goals of the Course

- Identify and apply the fundamental spatial, formal, and compositional concepts – space, form, light, program, and precedent – that underpin architectural design.

- Practice the iterative design process (brief analysis, ideation, model-making, critique, and revision) through short design exercises developed under a studio pin-up/desk-crit culture.
- Produce orthographic drawings (plans, sections, elevations) that correctly apply line-weight and drawing-set conventions.
- Build and present physical study and presentation models of a design proposal, from massing studies to a finished model.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

AG-A09) Creates architectural designs that satisfy aesthetic and technical requirements. (Usage)

5. Content

5.1 Foundations of Architectural Design, 10 hr(s)

Competences: AG-A09

Topics: **I:** Space, form, and order: positive and negative space, enclosure, threshold, spatial sequence, hierarchy, scale, and proportion as fundamental architectural design concepts **II:** Architectural elements and their spatial roles: wall, floor, ceiling, and roof as enclosure; column, beam, and slab as structure **III:** Composition and formal operations: symmetry, asymmetry, balance, rhythm, repetition, modulation, contrast, and tension as tools of architectural formal organization **IV:** Light and shadow as design media: natural light quality by orientation and time, shadow and material surface perception, light as spatial modifier - compression, expansion, focus **V:** Embodied perception of space: scale as bodily experienced rather than drawn, movement and kinesthetic sequence through space, and the visual, acoustic, and tactile engagement that shapes how a space is actually inhabited and felt **VI:** Materiality as an experiential design medium: texture, weight, surface finish, and color, and the atmosphere and character that material choice and craft give to a space, as distinct from a material's structural or technical properties **VII:** Program and spatial organization: functional zoning and bubble diagrams, circulation systems (horizontal, vertical, service), spatial hierarchy, and programmatic sequence **VIII:** Precedent study methods: formal analysis frameworks for canonical architectural works; reading plans, sections, and photographs as design intelligence

Learning Outcomes **I:** Identify and describe the key spatial, perceptual, material, and compositional concepts that constitute the foundations of architectural design [Familiarity] **II:** Apply foundational design principles - space, perception, materiality, light, program, and composition - in the development of a spatial architectural proposal [Usage] **III:** Evaluate a design or building project for the quality of its spatial organization, formal coherence, perceptual experience, material expression, and use of light and program, identifying strengths and areas for improvement [Assessment]

Bibliography: [Ching, 2015, Unwin, 2014]

5.2 Design Process and Creative Methods, 16 hr(s)

Competences: AG-A09

Topics: **I:** Brief analysis and problem framing: decomposing a design brief into spatial, functional, contextual, and performative requirements; identifying constraints and opportunities **II:** Architectural site analysis: solar orientation and sun path, prevailing wind and microclimate, topography and drainage, views and visual axes, vehicular and pedestrian access, surrounding urban fabric and context, and existing site constraints (easements, setbacks, utilities) as inputs to a design concept **III:** Design-criteria formulation: translating client and user requirements,

site-analysis findings, and regulatory constraints into a prioritized, measurable set of functional, spatial, environmental, and budgetary criteria used to generate and evaluate design alternatives **IV:** Ideation and concept development: sketching, diagramming, and collage as tools to explore spatial ideas; arriving at the parti (partido arquitectónico) – the single organizing idea that drives a design – and translating it into spatial and formal proposals **V:** Physical model-making as a design tool: study models for spatial exploration, massing studies, sectional models, and the role of making in discovering design solutions **VI:** Iterative design and critique: pin-up and desk critique culture, receiving and integrating feedback, revision cycles, and developing design judgment through reflection **VII:** Design narrative and argumentation: articulating design intent verbally and graphically, building a coherent design argument, and presenting spatial proposals persuasively **VIII:** Collaborative and interdisciplinary design processes: co-design with engineers, landscape architects, and community stakeholders

Learning Outcomes **I:** Describe the stages of an iterative architectural design process, from brief and site analysis through design-criteria formulation, concept development (parti), revision, and final proposal [Familiarity] **II:** Apply site analysis, design-criteria formulation, and systematic ideation and iterative critique methods to develop and refine a spatial architectural proposal in response to a design brief [Usage] **III:** Evaluate the coherence and effectiveness of a design process, including the quality of concept articulation, iteration, and responsiveness to critique [Assessment]

Bibliography: [Lawson, 2005, Unwin, 2014]

5.3 Orthographic Drawing and Conventions, 14 hr(s)

Competences: AG-A04

Topics: **I:** Orthographic projections: plan (cut plane at typical eye level or 1.5 m), section (cut through building, showing structure and spatial relationship), elevation (external **II:** Paraline drawings: isometric (equal angles, true scale), axonometric (plan oblique, elevation oblique), and their use in showing spatial depth without perspective distortion **III:** Perspective (conic projection) drawing: one-, two-, and three-point perspective construction, vanishing points, horizon line, and station point – the convergent-projection family used for experiential and presentation views, as distinct from the parallel-projection conventions of orthographic and paraline drawing **IV:** Freehand architectural sketching and schematic diagrams: quick observational sketches and on-site architectural studies ("apuntes") to record buildings and spaces, line quality and proportion by eye, light tonal shading, and parti, bubble, and concept diagrams as a loose, interpretive mode of representation distinct from measured hard-line drawing **V:** Line weight conventions: hierarchy of outline, section cut, foreground, middle ground, background, and hidden lines **VI:** Drawing set organization: title block, sheet numbering, drawing index; relationship between plans (architectural, structural, MEP, reflected ceiling), elevations, sections, **VII:** Dimensioning and annotation: string dimensions, overall dimensions, grid lines, spot elevations, section marks, finish labels, door and window tags **VIII:** Normalization of plan representation: ISO 128 (general principles) and ISO 5455 (scales) as international references; national drawing-set and plan-presentation requirements for permit submission (e.g. Peru's Reglamento Nacional de Edificaciones under Ley 29090)

Learning Outcomes **I:** Identify the standard orthographic, paraline, and perspective drawing types - plan, section, elevation, axonometric, isometric, one/two/three-point perspective - as well as freehand architectural sketching and diagrammatic schemas, and describe their respective uses [Familiarity] **II:** Produce a set of orthographic drawings (plan, section, elevation) for a small building that consistently applies line weight conventions, dimensioning, [Usage] **III:** Evaluate a set of architectural drawings for clarity, completeness, and adherence to graphic standards, identifying missing dimensions, inconsistent line weights, [Assessment]

Bibliography: [Ching, 2014]

6. Bibliography

[Ching, 2014] Ching, F. D. K. (2014). *Architectural Graphics*. Wiley, 6th edition.

[Ching, 2015] Ching, F. D. K. (2015). *Architecture: Form, Space, and Order*. Wiley, 4th edition.

[Lawson, 2005] Lawson, B. (2005). *How Designers Think: The Design Process Demystified*. Architectural Press, 4th edition.

[Unwin, 2014] Unwin, S. (2014). *Analysing Architecture*. Routledge, 4th edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1R1 Geometry and Analog Drawing (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 2 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

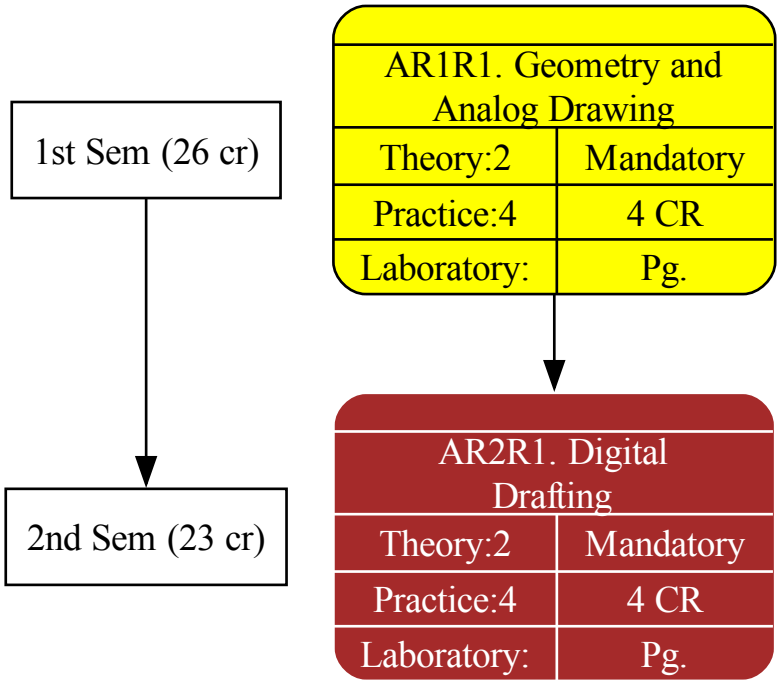


Figure 3.3: Connection Map. AR1R1 Geometry and Analog Drawing

2. Course Rationale

Geometry and Analog Drawing is the entry point of the Representation sequence (Analog Drawing I – Digital Drafting II – 3D Modeling and Animation III), which escalates from hand drawing to CAD/BIM to parametric 3D/XR over the first three semesters. Before any digital tool is introduced, students must master the underlying descriptive- geometry logic (projection, axonometry, perspective) and the drafting conventions (line weights, dimensioning, symbology) that every later digital workflow still encodes. The course grounds this in real urban elements – street sections, lots, public-space plans – rather than abstract solids, so the representational skill is immediately usable in the urbanism studio sequence.

3. Goals of the Course

- Apply descriptive-geometry principles (orthogonal projection, axonometry, conic perspective) to represent three-dimensional objects and spaces on a two-dimensional surface.

- Produce technical drawings by hand – plans, elevations, sections, and perspectives – following ISO/ANSI drafting conventions for line weights, dimensioning, scale, and symbology.
- Translate field observations (site sketches, measured surveys) into coordinated technical drawings suitable for urban and territorial analysis.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Assessment)

5. Content

5.1 Euclidean and Projective Geometry, 32 hr(s)

Competences: AG-A07

Topics: **I:** Euclidean geometry: axioms, congruence, similarity, and classical theorems **II:** Isometries of the plane and space: reflections, rotations, translations, and glide reflections **III:** Symmetry groups: frieze groups, wallpaper groups, and the classification of finite isometry groups **IV:** Projective plane: homogeneous coordinates, duality, and cross-ratio **V:** Conic sections in projective geometry: classification and projective transformations

Learning Outcomes **I:** Describe the axiomatic foundation of Euclidean geometry and identify the role of the parallel postulate [Familiarity] **II:** Classify isometries of the plane and determine the symmetry group of a given geometric figure [Usage] **III:** Apply projective coordinates and duality to prove classical theorems (Pappus, Desargues) [Assessment]

Bibliography: [Earle, 1996, Ching, 2015]

5.2 Orthographic Drawing and Conventions, 32 hr(s)

Competences: AG-A04

Topics: **I:** Orthographic projections: plan (cut plane at typical eye level or 1.5 m), section (cut through building, showing structure and spatial relationship), elevation (external **II:** Paraline drawings: isometric (equal angles, true scale), axonometric (plan oblique, elevation oblique), and their use in showing spatial depth without perspective distortion **III:** Perspective (conic projection) drawing: one-, two-, and three-point perspective construction, vanishing points, horizon line, and station point – the convergent-projection family used for experiential and presentation views, as distinct from the parallel-projection conventions of orthographic and paraline drawing **IV:** Freehand architectural sketching and schematic diagrams: quick observational sketches and on-site architectural studies ("apuntes") to record buildings and spaces, line quality and proportion by eye, light tonal shading, and parti, bubble, and concept diagrams as a loose, interpretive mode of representation distinct from measured hard-line drawing **V:** Line weight conventions: hierarchy of outline, section cut, foreground, middle ground, background, and hidden lines **VI:** Drawing set organization: title block, sheet numbering, drawing index; relationship between plans (architectural, structural, MEP, reflected ceiling), elevations, sections, **VII:** Dimensioning and annotation: string dimensions, overall dimensions, grid lines, spot elevations, section marks, finish labels, door and window tags **VIII:** Normalization of plan representation: ISO 128 (general principles) and ISO 5455 (scales) as international references; national drawing-set and plan-presentation requirements for permit submission (e.g. Peru's Reglamento Nacional de Edificaciones under Ley 29090)

Learning Outcomes I: Identify the standard orthographic, paraline, and perspective drawing types - plan, section, elevation, axonometric, isometric, one/two/three-point perspective - as well as freehand architectural sketching and diagrammatic schemas, and describe their respective uses [Familiarity] **II:** Produce a set of orthographic drawings (plan, section, elevation) for a small building that consistently applies line weight conventions, dimensioning, [Usage] **III:** Evaluate a set of architectural drawings for clarity, completeness, and adherence to graphic standards, identifying missing dimensions, inconsistent line weights, [Assessment]

Bibliography: [Ching, 2015, Wellman, 2020]

5.3 Graphic Symbols and Drafting Conventions, 32 hr(s)

Competences: AG-A04

Topics: I: Architectural element symbols: door swing and window types in plan, wall representation and hatching by material (concrete, masonry, drywall, wood), and stair/ramp conventions (up/down arrows, break lines, nosing) **II:** Furniture and fixed-equipment symbols: furniture blocks (seating, tables, beds), kitchen and bathroom fixtures, and standard clearances shown in plan **III:** Building-systems symbol libraries: electrical symbols (outlets, switches, lighting fixtures, panels) and plumbing/sanitary symbols (fixtures, supply and drainage lines) **IV:** Material hatching and texture conventions in plan and section: concrete, earth, insulation, wood, and stone, and their standard graphic representation **V:** Landscape and site symbols: planting symbols by canopy size and species type, paving and hardscape textures, and vehicle/parking symbols for site plans **VI:** Signage and wayfinding symbols: accessibility pictograms, means-of-egress and exit signage, and room-numbering conventions **VII:** Structural drawing conventions: column/structural grid notation, beam and slab representation, and reinforcement symbols in structural drawings

Learning Outcomes I: Identify the standard graphic symbols for architectural elements, furniture, building systems (MEP), site/landscape features, signage, and structural components [Familiarity] **II:** Apply standard symbol and hatching conventions consistently across a set of architectural drawings, including furniture, MEP, landscape, and structural symbols [Usage] **III:** Evaluate a set of architectural drawings for correct and consistent use of graphic symbols and conventions, identifying non-standard or ambiguous symbol use [Assessment]

Bibliography: [Ching, 2015]

6. Bibliography

[Ching, 2015] Ching, F. D. K. (2015). *Architectural Graphics*. Wiley, 6th edition.

[Earle, 1996] Earle, J. H. (1996). *Engineering Design Graphics*. Addison-Wesley, 8th edition.

[Wellman, 2020] Wellman, B. L. (2020). *Technical Drawing 101 with AutoCAD*. Pearson, 5th edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

MA100 Basic Mathematics (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 5
- **Hour of this course**: **Theory**: 3 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

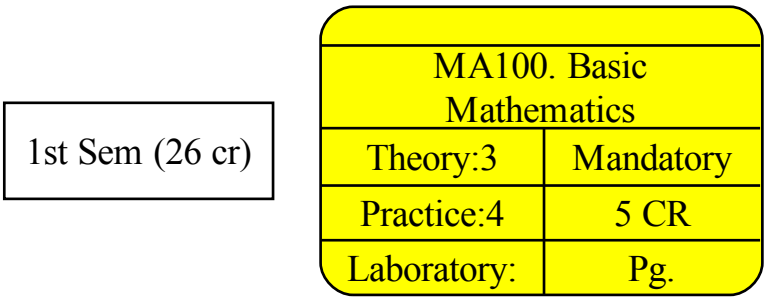


Figure 3.4: Connection Map. MA100 Basic Mathematics

2. Course Rationale

The Basic Mathematics course is mandatory and provides the conceptual tools necessary for logical reasoning and problem solving. The course ranges from propositional logic and set theory to the study of real numbers, complex numbers, polynomials, and matrices. These concepts are fundamental for developing the abstraction and mathematical formalization skills required in the later stages of the Computer Science program.

3. Goals of the Course

- Develop logical reasoning and critical thinking skills through the use of formal languages.
- Understand and apply the properties of number systems (real and complex) in problem solving.
- Manipulate polynomial and matrix structures to solve systems of equations and interpret results.
- Introduce basic concepts of statistics and probability for data analysis.

4. General Competences (*Outcomes*)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Familiarity)

5. Content

5.1 Logic and Sets, 16 hr(s)

Competences: AG-A07

Topics: **I:** Propositional logic: Connectives, truth tables, and validity. **II:** Logical-mathematical quantifiers. **III:** Set theory: Operations, relations, and functions. **IV:** Families of sets and Cartesian product.

Learning Outcomes **I:** Formalize natural language statements into propositional language [Familiarity]. **II:** Operate with sets using algebraic laws and Venn diagrams [Usage]. **III:** Prove basic properties of sets and logical relations [Assessment].

Bibliography: [Lipschutz, 1991, Rojo, 1995]

5.2 Number Systems, 16 hr(s)

Competences: AG-A07

Topics: **I:** The real number system: Field and order axioms. **II:** Mathematical induction and Newton's binomial theorem. **III:** Complex numbers: Binomial, polar, and exponential forms. **IV:** Roots of complex numbers and De Moivre's theorem.

Learning Outcomes **I:** Identify the algebraic structure of real and complex numbers [Familiarity]. **II:** Apply the principle of mathematical induction in proofs of summations [Usage]. **III:** Solve equations in the complex number field using various representations [Assessment].

Bibliography: [Gentile, 1985, Álvaro Pinzón, 1973]

5.3 Polynomials and Matrices, 16 hr(s)

Competences: AG-A07

Topics: **I:** Polynomials: Division algorithm and roots of polynomials. **II:** Matrices: Types, operations, and determinants. **III:** Inverse matrix and rank of a matrix. **IV:** Systems of linear equations: Gauss-Jordan method.

Learning Outcomes **I:** Recognize the structure of polynomial rings and matrix algebra [Familiarity]. **II:** Use elementary row operations to calculate the inverse of a matrix [Usage]. **III:** Model and solve systems of linear equations applied to contextual problems [Assessment].

Bibliography: [Gentile, 1984, Rojo, 1995]

5.4 Statistics and Probability, 16 hr(s)

Competences: AG-A07

Topics: **I:** Descriptive statistics: Measures of central tendency. **II:** Dispersion measures and graphical representation. **III:** Probability concepts: Sample space and events. **IV:** Conditional probability and independence.

Learning Outcomes **I:** Describe data sets using basic statistical indicators [Familiarity]. **II:** Calculate probabilities of simple and compound events in random experiments [Usage]. **III:** Interpret statistical results for decision making in scientific environments [Assessment].

Bibliography: [Peterson, 2005]

6. Bibliography

[Gentile, 1984] Gentile, E. (1984). *Notas de álgebra*. Editorial Universitaria de Buenos Aires.

[Gentile, 1985] Gentile, E. (1985). *Aritmética Elemental*. Colección de Monografías Científicas Ser.

[Lipschutz, 1991] Lipschutz, S. (1991). *Teoría de conjuntos y temas afines*. McGraw-Hill.

[Peterson, 2005] Peterson, J. (2005). *Matemática básica*. Prentice-Hall.

[Rojo, 1995] Rojo, A. (1995). *Álgebra I*. El Ateneo.

[Álvaro Pinzón, 1973] Álvaro Pinzón (1973). *Conjuntos y estructuras*. Blaisdell Publishing Company.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

MA111 Calculus I (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 5
- **Hour of this course**: **Theory**: 3 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

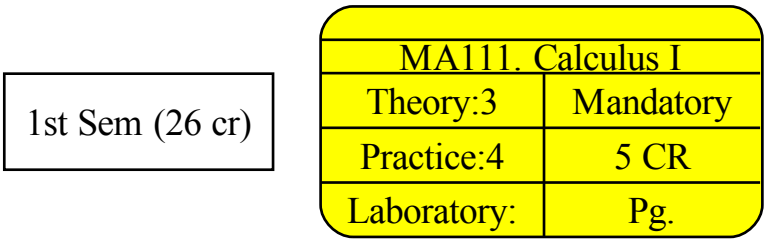


Figure 3.5: Connection Map. MA111 Calculus I

2. Course Rationale

This course introduces the fundamental concepts of differential calculus of single-variable real functions. It provides the mathematical foundations necessary for analyzing change and motion in science and engineering, developing logical reasoning through the study of limits, continuity, and derivatives.

3. Goals of the Course

- Understand the fundamental concepts of limits and continuity.
- Master differentiation techniques for algebraic and transcendental functions.
- Apply derivatives to solve optimization problems and analyze rates of change.
- Develop a rigorous approach to the formal definition of a derivative.

4. General Competences (*Outcomes*)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Familiarity)

5. Content

5.1 Limits and Continuity, 20 hr(s)

Competences: AG-A07

Topics: I: Limits and continuity of single-variable functions

Learning Outcomes I: Interpret the concept of limit and continuity of a function and its relevance to modeling the behavior of architectural systems near a point [Familiarity]

Bibliography: [Stewart, 2016, Larson and Edwards, 2018, Thomas et al., 2014]

5.2 Differential Calculus, 20 hr(s)

Competences: AG-A07

Topics: **I:** Derivatives and rules of differentiation

Learning Outcomes **I:** Apply differentiation rules to find rates of change and optimize architectural design parameters [Usage] **II:** Formulate and solve optimization problems for architectural systems using differential calculus [Assessment]

Bibliography: [Stewart, 2016, Larson and Edwards, 2018, Thomas et al., 2014]

5.3 Integral Calculus, 10 hr(s)

Competences: AG-A07

Topics: **I:** The Fundamental Theorem of Calculus **II:** Integration techniques including substitution and parts **III:** Architectural applications of integration: areas, volumes, centroids, and moments of inertia

Learning Outcomes **I:** State and explain the Fundamental Theorem of Calculus [Familiarity] **II:** Calculate definite integrals arising from architectural problems such as work, fluid pressure, and heat transfer [Usage]

Bibliography: [Stewart, 2016, Larson and Edwards, 2018, Thomas et al., 2014]

6. Bibliography

[Larson and Edwards, 2018] Larson, R. and Edwards, B. H. (2018). *Cálculo*. Cengage Learning, 10th edition.

[Stewart, 2016] Stewart, J. (2016). *Cálculo de una variable: Trascendentes tempranas*. Cengage Learning, 8th edition.

[Thomas et al., 2014] Thomas, G. B., Weir, M. D., and Hass, J. (2014). *Cálculo de una variable*. Pearson, 13th edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG163 Communication I (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours;
- **Prerrequisites**: None

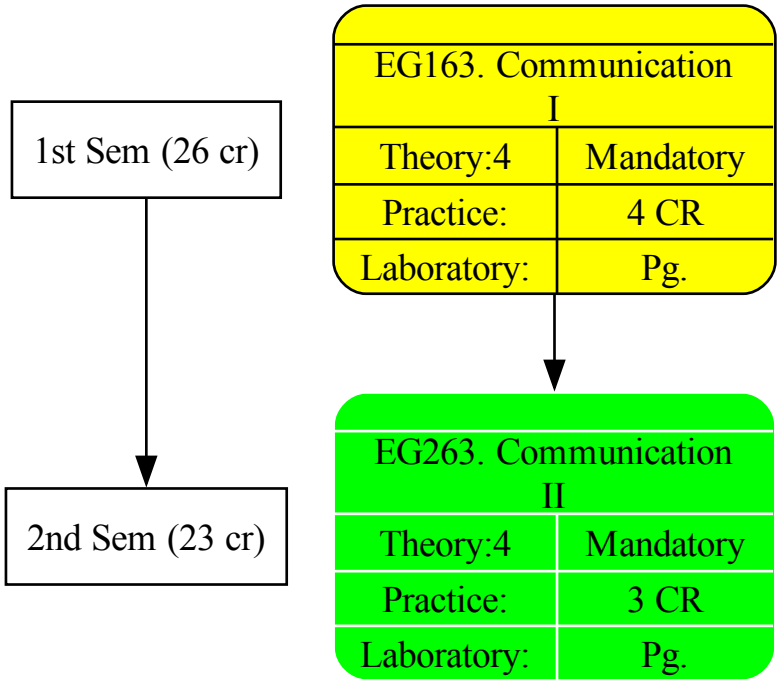


Figure 3.6: Connection Map. EG163 Communication I

2. Course Rationale

Comunicación I es el primer curso de la línea de comunicación del Área de Estudios Generales, de naturaleza teórico-práctica y carácter obligatorio. Desarrolla la competencia comunicativa del estudiante para que sea capaz de aplicar técnicas y herramientas de expresión oral, enfatizando en la lectura y comprensión de textos literarios y no literarios, así como en habilidades esenciales para la escritura y producción de textos sencillos, aplicando la normatividad vigente del español. Cubre la comunicación humana y sus elementos, las técnicas y estrategias de expresión oral en disertaciones breves y el discurso, la determinación y el análisis personal del nivel de comprensión de lectura, y la producción de textos sencillos y cotidianos, ensayos breves y documentos administrativos de uso común.

3. Goals of the Course

- Identificar los elementos y niveles del proceso de comunicación humana, reconociendo la realidad lingüística del Perú.

- Aplicar técnicas y estrategias de expresión oral en disertaciones breves y discursos académicos.
- Desarrollar estrategias de comprensión lectora para el análisis de textos literarios y no literarios.
- Producir textos sencillos, ensayos breves y documentos administrativos de uso frecuente con corrección idiomática.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

5. Content

5.1 La comunicación, funciones y niveles de lenguaje, realidad lingüística en el Perú, 25 hr(s)

Competences: AG-A04

Topics: **I:** La comunicación humana: concepto y elementos que intervienen en el proceso de comunicación. **II:** Formas de comunicación, cualidades de una comunicación adecuada, comunicación efectiva y barreras de la comunicación. **III:** Naturaleza y propiedades universales del lenguaje. Funciones del lenguaje. **IV:** Niveles de la lengua, diversificación del español en el Perú, lenguas peruanas, bilingüismo y realidad lingüística del Perú. **V:** Niveles, técnicas y estrategias de lectura. Análisis y crítica en la lectura.

Learning Outcomes **I:** Explica el concepto de comunicación humana y esquematiza los elementos que intervienen en el proceso comunicativo. [Familiarity]. **II:** Establece las principales cualidades de una comunicación adecuada y reconoce sus barreras. [Usage]. **III:** Reconoce la importancia de la lengua estándar y culta, y la realidad lingüística y el bilingüismo del Perú, para su formación académica. [Usage]. **IV:** Lee y comprende textos, desarrollando un cuestionario como evidencia de comprensión y análisis textual. [Usage].

Bibliography: [ADUNI, 2003, Fonseca et al., 2011]

5.2 La comunicación oral, técnicas y estrategias de expresión oral en disertaciones breves y el discurso, 35 hr(s)

Competences: AG-A04

Topics: **I:** Oratoria: base teórica, técnicas y finalidad. **II:** Corporalidad y comunicación: cualidades del orador, estilo y posturas corporales. El discurso: estructura y contenido. **III:** Propiedad léxica. El texto expositivo oral. Técnicas y recursos para la exposición oral y académica. **IV:** Las dinámicas grupales y el trabajo en equipo: concepto, tipos y proceso de formación de grupos. **V:** Tildación enfática y de palabras compuestas. Ortografía de la oración: signos de puntuación.

Learning Outcomes **I:** Elabora y expone un discurso formal ante sus compañeros, aplicando las bases teóricas y técnicas de la oratoria. [Usage]. **II:** Identifica las propiedades de una buena elocución y realiza ejercicios para mejorar la vocalización, la dicción y la corporalidad en la exposición oral. [Usage]. **III:** Planifica y dirige una exposición académica utilizando recursos multimedia. [Usage]. **IV:** Planifica el desarrollo de dinámicas grupales (panel, foro, debate, mesa redonda, simposio, seminario) sobre un tema actual. [Usage]. **V:** Aplica las reglas de tildación enfática, tildación de palabras compuestas y ortografía de la oración (signos de puntuación) en prácticas dirigidas y calificadas. [Usage].

Bibliography: [Faccini, 2018, Española, 2012]

5.3 Redacción de textos sencillos, ensayos breves y documentos administrativos de uso común, 30 hr(s)

Competences: AG-A04

Topics: **I:** El texto: tipos, formatos y estructuras. Texto continuo, discontinuo, mixto y múltiple. **II:** Textos argumentativos y descriptivos. El texto expositivo. **III:** El párrafo: características y clasificación (introducción, desarrollo y conclusión). **IV:** Redacción: concepto, importancia y habilidades para una óptima redacción. Importancia de la redacción en el campo ocupacional del arquitecto. **V:** Documentos administrativos: solicitud, memorial, oficio, carta, informe técnico, memorando, acta y curriculum vitae.

Learning Outcomes I: Distingue los tipos, formatos y estructuras de texto (continuo, discontinuo, mixto y múltiple) a través de prácticas calificadas. [Usage]. **II:** Analiza y reconoce la estructura de un texto expositivo, y redacta un ensayo breve sobre un tema social de coyuntura aplicando correctamente las reglas ortográficas y gramaticales. [Usage]. **III:** Redacta los párrafos de introducción, desarrollo y conclusión de un texto expositivo. [Usage]. **IV:** Aplica las características de una buena redacción y las normas ortográficas en la elaboración de textos administrativos (solicitud, memorial, oficio, carta, informe técnico, memorando, acta, curriculum vitae). [Usage].

Bibliography: [Godoy, 2012, García, 2023]

6. Bibliography

[ADUNI, 2003] ADUNI (2003). *Propedéutica de Razonamiento Verbal*. Lumbreras Editores.

[Española, 2012] Española, R. A. (2012). *Ortografía de la Lengua Española*. Editorial Planeta Colombiana S.A., 2nd edition.

[Faccini, 2018] Faccini, D. (2018). *Oratoria Siglo XXI: Técnicas para Vencer el Miedo a Hablar en Público y ser un Orador Exitoso*. Ugerman Editor.

[Fonseca et al., 2011] Fonseca, Y., Correa, A., Pineda, M., and Lemus, F. J. (2011). *Comunicación Oral y Escrita*. Pearson Educación, 1st edition.

[García, 2023] García, S. G. (2023). *Expresión y Exposición Oral y Escrita 1*. Grupo Editorial Éxodo, 1st edition.

[Godoy, 2012] Godoy, M. (2012). *Cómo Mejorar la Redacción y Algo Más*. Valletta Ediciones.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG164 Digital Competencies Development (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

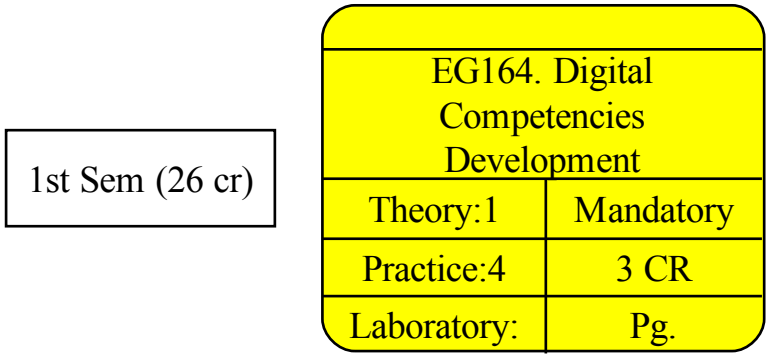


Figure 3.7: Connection Map. EG164 Digital Competencies Development

2. Course Rationale

Desarrollo de Competencias Digitales pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórico-práctica. Tiene como propósito desarrollar las competencias digitales de los estudiantes en las dimensiones de información, comunicación y creación de contenido, de modo que puedan utilizar de manera más efectiva los recursos que ofrecen las tecnologías de información y comunicación y aplicarlas en sus tareas académicas. Cubre la búsqueda, organización y almacenamiento de información; el uso de herramientas de comunicación y trabajo colaborativo en línea; y la creación de contenido mediante procesadores de texto, presentaciones y hojas de cálculo, con énfasis en la ética informática.

3. Goals of the Course

- Demostrar manejo de las TIC para la búsqueda, organización y almacenamiento de información.
- Aplicar herramientas de comunicación y trabajo colaborativo en línea con criterios de seguridad y ética informática.
- Crear contenido digital (textos, presentaciones y hojas de cálculo) utilizando herramientas avanzadas, reconociendo su importancia en el trabajo académico.

4. General Competences (*Outcomes*)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Usage)

5. Content

5.1 Dimensión de Información, 20 hr(s)

Competences: AG-A07

Topics: **I:** Búsqueda de información: principios básicos, motores de búsqueda y operadores booleanos. **II:** Organización y almacenamiento digital: estructura de carpetas y etiquetado. Hosting y servicios de alojamiento de información. **III:** Herramientas avanzadas de navegadores: funciones avanzadas de personalización. Seguridad y privacidad digital. **IV:** Herramientas de información en línea: bases de datos académicas, repositorios y bibliotecas virtuales. Evaluación de fuentes especializadas. **V:** Uso de inteligencia artificial para la búsqueda de información: elaboración de prompts y uso responsable.

Learning Outcomes **I:** Utiliza los diferentes buscadores digitales según criterios de eficiencia, coherencia y calidad, aplicando operadores booleanos. [Usage]. **II:** Comprende el uso práctico de plataformas de almacenamiento en la nube y ejecuta simulaciones de organización de archivos de proyectos. [Usage]. **III:** Instala y configura extensiones de navegadores para mejorar la productividad y la seguridad digital. [Usage]. **IV:** Integra herramientas de inteligencia artificial de manera responsable y ética en la búsqueda de información, presentando un proyecto digital integrador. [Usage].

Bibliography: [Aznar, 2014, González, 2017]

5.2 Dimensión de Comunicación, 28 hr(s)

Competences: AG-A06

Topics: **I:** Comunicación digital: fundamentos. Redes sociales y transacciones en línea. **II:** El trabajo colaborativo vs. el trabajo en grupo de manera aislada. Plataformas para reuniones virtuales (Google Meet, Zoom, Teams). Calendarios y carpetas colaborativas. **III:** Blogs, foros y wikis para compartir conocimiento. Moderación y gestión de comunidades virtuales. **IV:** Gestión del conocimiento en línea. Comunicación síncrona y asíncrona: diferencias, ventajas, protocolos y etiqueta digital. **V:** Transacciones en línea: seguridad, fundamentos de protección en transacciones online y análisis de plataformas de pago.

Learning Outcomes **I:** Configura perfiles profesionales en plataformas digitales y realiza simulaciones de networking en línea. [Usage]. **II:** Organiza y conduce reuniones virtuales, creando, agendando y asignando tareas para trabajos colaborativos. [Usage]. **III:** Gestiona de manera efectiva blogs, foros y wikis, moderando y compartiendo conocimiento en comunidades virtuales. [Usage]. **IV:** Redacta y organiza correos electrónicos formales, aplicando protocolos y etiqueta digital en la comunicación síncrona y asíncrona. [Usage]. **V:** Analiza plataformas de pago y simula transacciones seguras, aplicando criterios de seguridad digital. [Usage].

Bibliography: [Herrera, 2018, Jiménez, 2019]

5.3 Dimensión de Creación de Contenido, 24 hr(s)

Competences: AG-A07

Topics: **I:** Dominio del procesador de texto. Uso avanzado en la elaboración de informes y documentos técnicos. La redacción clara y precisa en proyectos arquitectónicos. **II:** Creación de presentaciones digitales I: herramientas y principios básicos (PowerPoint, Google Slides, Canva). **III:** Creación de presentaciones digitales II: opciones avanzadas, técnicas de animación, transiciones, elementos interactivos y storytelling visual aplicado a la arquitectura. **IV:** Uso de hojas de cálculo para proyectos: funcionalidades en la gestión de presupuestos, análisis de datos y cálculos estructurales. **V:** Ética informática y propiedad intelectual: principios éticos en la creación y uso de contenido digital, derechos de autor y uso responsable de la información.

Learning Outcomes **I:** Revisa y edita de manera colaborativa documentos técnicos, ejercitando el uso avanzado del procesador de texto. [Usage]. **II:** Diseña diapositivas incorporando multimedia y estructuras narrativas, aplicando herramientas y principios básicos de presentaciones digitales (PowerPoint, Google Slides, Canva). [Usage]. **III:** Aplica herramientas avanzadas de presentaciones, incluyendo animaciones, transiciones y storytelling visual aplicado a la arquitectura. [Usage]. **IV:** Crea y manipula hojas de cálculo para la gestión de presupuestos, análisis de datos y cálculos estructurales de manera colaborativa. [Usage]. **V:** Analiza principios éticos en la creación y uso de contenido digital, y los derechos de autor y propiedad intelectual. [Usage].

Bibliography: [Paredes, 2017, Castillo, 2018]

6. Bibliography

[Aznar, 2014] Aznar, I. (2014). Gestión de la información digital.

[Castillo, 2018] Castillo, E. (2018). Ética informática y derechos digitales.

[González, 2017] González, S. (2017). Ciberseguridad y protección de datos.

[Herrera, 2018] Herrera, M. (2018). Comunicación digital y redes profesionales.

[Jiménez, 2019] Jiménez, C. (2019). Trabajo colaborativo y productividad digital.

[Paredes, 2017] Paredes, F. (2017). Hojas de cálculo aplicadas a la arquitectura.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG165 Strategies for Autonomous Learning (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

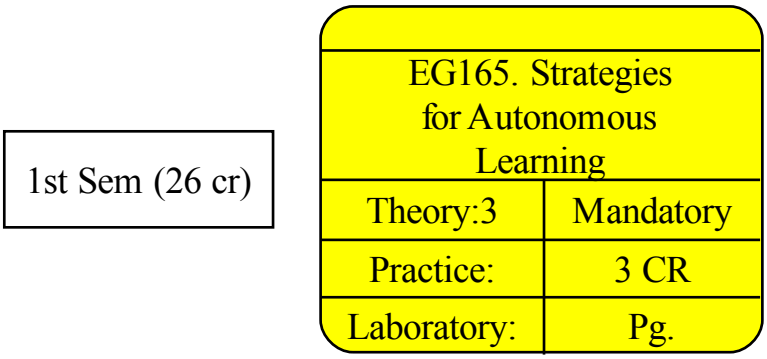


Figure 3.8: Connection Map. EG165 Strategies for Autonomous Learning

2. Course Rationale

Estrategias para el Aprendizaje Autónomo pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito que los estudiantes desarrollen habilidades y estrategias de aprendizaje que les permitan desempeñarse como aprendices autónomos, haciendo uso eficiente del tiempo y de los recursos de información disponibles para mejorar los resultados de aprendizaje en los cursos de su carrera y lograr una adaptación exitosa a la vida universitaria. Cubre el autodiagnóstico de estrategias de aprendizaje y habilidades para el estudio, los enfoques y estilos de aprendizaje, las estrategias de aprendizaje (cognitivas, afectivas, metacognitivas) y las herramientas y técnicas para mejorarlas.

3. Goals of the Course

- Analizar aspectos importantes de la universidad, la ley universitaria y el conocimiento y la investigación científica en la universidad.
- Analizar la importancia de las estrategias, enfoques y estilos de aprendizaje, y las herramientas para mejorarlas.
- Comprender la importancia de la elaboración de trabajos científicos y académicos en la vida universitaria.

4. General Competences (*Outcomes*)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Familiarity)

5. Content

5.1 La Universidad y la Investigación, 15 hr(s)

Competences: AG-A10

Topics: **I:** La universidad: orígenes, conceptualización y funciones. **II:** La Ley Universitaria Nº 30220. **III:** La SUNEDU. La universidad comprometida con los Objetivos de Desarrollo Sostenible. **IV:** El conocimiento y la investigación científica en la universidad.

Learning Outcomes **I:** Describe aspectos importantes del origen de las universidades en el mundo y en el Perú, y analiza su importancia en forma grupal e individual. [Familiarity]. **II:** Analiza los aspectos importantes de la nueva ley universitaria (Ley Nº 30220). [Familiarity]. **III:** Identifica la importancia de la SUNEDU en el Perú y de las universidades en los objetivos de desarrollo sostenible. [Familiarity]. **IV:** Analiza la importancia del conocimiento y la investigación científica en la universidad. [Familiarity].

Bibliography: [Educación, 2014, de Ridder-Symoens, 1994]

5.2 Estilos y Estrategias de Aprendizaje, 21 hr(s)

Competences: AG-A06

Topics: **I:** Autodiagnóstico de estrategias de aprendizaje y habilidades para el estudio. Teorías del aprendizaje. **II:** Enfoques de aprendizaje. **III:** Estilos de aprendizaje. **IV:** Estrategias de aprendizaje: concepto, tipos (cognitivas, afectivas, metacognitivas). **V:** Herramientas y técnicas para mejorar las estrategias de aprendizaje.

Learning Outcomes **I:** Identifica estrategias de aprendizaje y habilidades para el estudio, y reconoce las principales teorías del aprendizaje (conductista, cognitivista, constructivista, sociocultural y aprendizaje significativo). [Usage]. **II:** Identifica y analiza los diversos enfoques de aprendizaje para el proceso de aprendizaje. [Usage]. **III:** Identifica y analiza los estilos de aprendizaje a nivel grupal e individual. [Usage]. **IV:** Identifica y analiza las diversas estrategias de aprendizaje (cognitivas, afectivas, metacognitivas) en el proceso de enseñanza. [Usage]. **V:** Identifica las diversas herramientas y técnicas para mejorar las estrategias de aprendizaje. [Usage].

Bibliography: [Reyes, 2017, Carrasco, 2004]

5.3 Elaboración de Trabajos Científicos, 18 hr(s)

Competences: AG-A10

Topics: **I:** Proceso para la elaboración de trabajos científicos y académicos: la monografía, informes de investigación y trabajos de investigación. **II:** Estructura de la monografía. **III:** Estructura del informe de investigación. **IV:** Estructura de los trabajos de investigación.

Learning Outcomes **I:** Analiza y describe el proceso para la elaboración de trabajos científicos y académicos: la monografía, los informes de investigación y los trabajos de investigación. [Usage]. **II:** Identifica las partes y elabora una monografía a nivel grupal. [Usage]. **III:** Identifica las partes y elabora un informe de investigación a nivel individual. [Usage]. **IV:** Identifica las partes y elabora un trabajo de investigación, resolviendo el cuestionario de unidad. [Usage].

Bibliography: [Ander-Egg, 2017, Day, 2005]

6. Bibliography

[Ander-Egg, 2017] Ander-Egg, E. (2017). *Cómo Elaborar Monografías, Artículos Científicos y Otros Textos Expositivos*. Homo Sapiens Ediciones.

[Carrasco, 2004] Carrasco, J. B. (2004). *Estrategias de Aprendizaje. Para Aprender Más y Mejor*. Ediciones Rialp.

[Day, 2005] Day, R. A. (2005). *Cómo Escribir y Publicar Trabajos Científicos*. Organización Panamericana de la Salud, 3rd edition.

[de Ridder-Symoens, 1994] de Ridder-Symoens, H. (1994). *Las Universidades en la Edad Media*. Servicio Editorial, Universidad del País Vasco.

[Educación, 2014] Educación, M. (2014). Ley universitaria (ley 30220).

[Reyes, 2017] Reyes, D. A. (2017). El mapa mental: Una estrategia cognitiva de aprendizaje.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG166 Basic Mathematics (Mandatory)

1. General information

- **Semester**: 1st Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 2 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

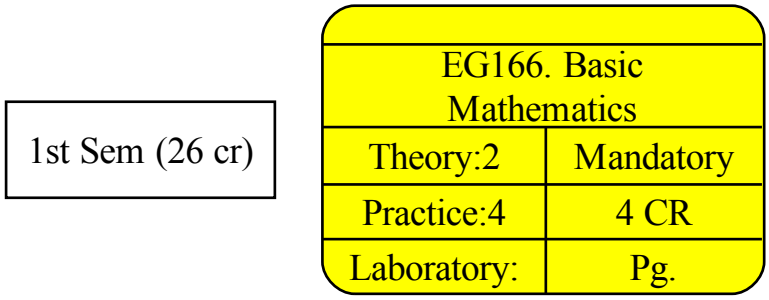


Figure 3.9: Connection Map. EG166 Basic Mathematics

2. Course Rationale

Matemática Básica pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórico-práctica. Tiene como propósito desarrollar el pensamiento lógico, la conexión matemática y la resolución de problemas en situaciones del contexto real y aplicado a la arquitectura. Comprende la teoría de conjuntos y sus operaciones, el sistema de números reales, ecuaciones lineales y cuadráticas con dos y tres variables, inecuaciones lineales y cuadráticas, funciones, proporcionalidad, semejanza de triángulos, área de figuras planas y su ubicación en el plano cartesiano, lógica proposicional y esquemas lógicos.

3. Goals of the Course

- Aplicar principios fundamentales de teoría de exponentes, lógica proposicional y teoría de conjuntos en la resolución de casos aplicados a la arquitectura.
- Analizar y resolver ecuaciones e inecuaciones, y problemas con sistemas de ecuaciones, aplicados a la arquitectura.
- Interpretar y aplicar conceptos fundamentales de geometría analítica a la resolución de problemas de áreas, perímetros y figuras aplicados a la arquitectura.

4. General Competences (*Outcomes*)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Usage)

5. Content

5.1 Teoría de Exponentes, Lógica Proposicional y Teoría de Conjuntos, 30 hr(s)

Competences: AG-A07

Topics: **I:** Conjunto de números reales. Teoría de exponentes: propiedades. **II:** Racionalización. Simplificación de expresiones irracionales. **III:** Lógica proposicional: definiciones, lenguaje proposicional, interpretación de operadores. **IV:** Teoría de conjuntos: definición, notación, gráfica, pertenencia, inclusión. Producto cartesiano. **V:** Productos notables: propiedades.

Learning Outcomes **I:** Aplica propiedades de la teoría de exponentes en la simplificación de expresiones y resuelve ejercicios con números irracionales aplicando racionalización. [Usage]. **II:** Comprende las nociones fundamentales de la lógica proposicional e identifica los conectores lógicos, aplicando correctamente el lenguaje proposicional en la resolución de ejercicios y problemas. [Usage]. **III:** Identifica las clases y realiza operaciones aplicando propiedades de la teoría de conjuntos, incluyendo el producto cartesiano. [Usage]. **IV:** Conoce las propiedades de productos notables y las aplica en la simplificación de expresiones algebraicas. [Usage].

Bibliography: [Baldeón, 2007, Lumbreras,]

5.2 Sistema de Números Reales. Ecuaciones e Inecuaciones, 42 hr(s)

Competences: AG-A07

Topics: **I:** Ecuaciones: definición, planteamiento y resolución de casos con ecuaciones lineales. **II:** Ecuaciones cuadráticas: desarrollo de ejercicios y problemas de ecuaciones aplicados a la arquitectura. **III:** Sistema de ecuaciones: métodos de resolución. **IV:** Inecuaciones: definición, teoremas, resolución de ejercicios de desigualdades lineales. **V:** Aplicaciones de ecuaciones e inecuaciones en arquitectura.

Learning Outcomes **I:** Resuelve ecuaciones lineales con una variable y problemas aplicando propiedades de las ecuaciones relacionados con su carrera. [Usage]. **II:** Resuelve ecuaciones cuadráticas aplicando factorización, completando cuadrados y la fórmula general. [Usage]. **III:** Evalúa los métodos de resolución de sistemas de ecuaciones e interpreta las soluciones en el desarrollo de ejercicios aplicados a la arquitectura. [Usage]. **IV:** Define e interpreta la solución de desigualdades de primer grado, cuadráticas y racionales con una incógnita. [Usage]. **V:** Traduce e interpreta la expresión verbal al lenguaje algebraico para la resolución de problemas de ecuaciones e inecuaciones aplicados a la arquitectura. [Usage].

Bibliography: [B., , Máltsev,]

5.3 Geometría en Arquitectura, 36 hr(s)

Competences: AG-A07

Topics: **I:** Introducción a la geometría analítica: punto, recta y polígonos en el plano cartesiano. **II:** La recta: ángulo de inclinación, pendiente, ecuación de la recta, distancia entre dos puntos, punto medio y división de segmentos. **III:** La parábola: elementos, propiedades, clasificación y ecuación. **IV:** Perímetro y área de figuras poligonales en 2D, descripción de lotes por orientación magnética y por ubicación. **V:** Perímetro y área de cilindros y prismas aplicados a la arquitectura.

Learning Outcomes **I:** Conoce y aplica correctamente la teoría de geometría analítica (punto, recta y polígonos en el plano cartesiano) para resolver ejercicios y problemas de áreas de polígonos. [Usage]. **II:** Utiliza los conceptos de la recta (ángulo de inclinación, pendiente, distancia entre dos puntos, punto medio) en la resolución de ejercicios y problemas. [Usage]. **III:** Identifica y grafica la ecuación de la parábola, resolviendo problemas de aplicación en casos prácticos de arquitectura. [Usage]. **IV:** Realiza cálculos de área y perímetro de figuras poligonales en 2D, cilindros y prismas, aplicados a la arquitectura. [Usage].

Bibliography: [Leithold, , Ballester,]

6. Bibliography

[B.,] B., E. A. *Análisis Matemático 1.*

[Baldeón, 2007] Baldeón, A. V. (2007). *Análisis Matemático I.*

[Ballester,] Ballester, J. A. *Geometría para la Arquitectura.*

[Leithold,] Leithold, L. *El Cálculo con Geometría Analítica.*

[Lumbreras,] Lumbreras, C. *Matemáticas Básicas: Lógica, Conjuntos.* Editorial Lumbreras.

[Máltsev,] Máltsev, A. I. *Fundamentos de Álgebra Lineal.*

Second Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1B2 Parametric Modeling and Generative Design (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR1B1 Introduction to BIM (1st Sem-Pg. 41)

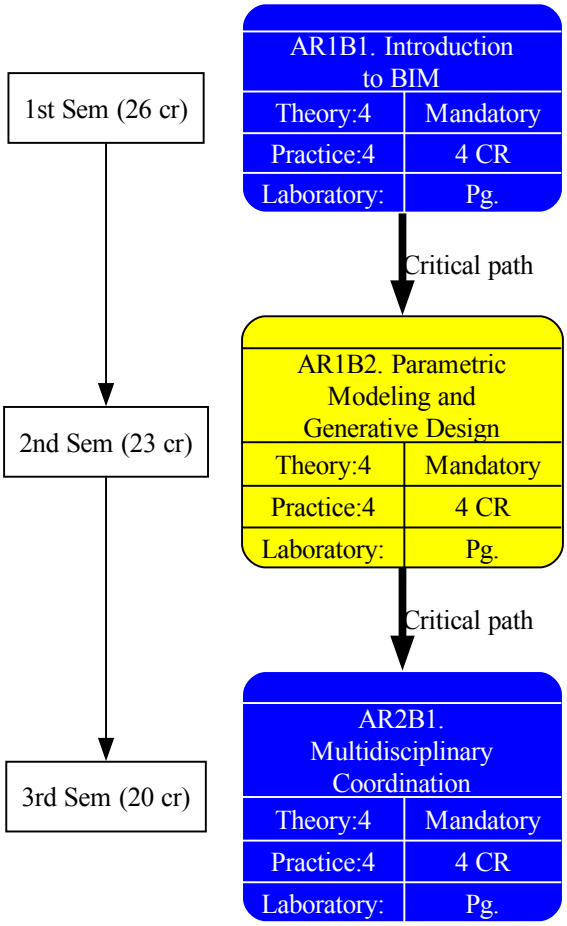


Figure 3.10: Connection Map. AR1B2 Parametric Modeling and Generative Design

2. Course Rationale

Parametric Modeling and Generative Design is the second course of the obligatory BIM I-X sequence, requiring Introduction to BIM (AR1B1) as a prerequisite. Where AR1B1 establishes object-based authoring, LOD, and model-derived documentation, this course extends that authoring skillset

into parametric and generative territory: building custom parametric families and components, driving them with visual scripting (Dynamo, Grasshopper-to-Revit), and coupling a parametric model to a performance metric to generate and compare design options (generative design/optioneering). A third unit grounds this computational work physically, taking a digital model through CNC, laser-cutting, 3D-printing, or robotic-fabrication workflows to produce a prototype – the KU this course is the first to actually use. The recurring software-practicum unit anchors all of this in guided, certification-aligned exercises specific to the course's parametric/generative tool focus, preparing students for the multidisciplinary model coordination they will take on next in Multidisciplinary Coordination (AR2B1).

3. Goals of the Course

- Author parametric BIM families and components, and use visual-scripting tools (Dynamo, Grasshopper-to-Revit) to automate repetitive modeling and data-extraction tasks.
- Set up and run generative-design/optioneering workflows that couple a parametric model to a quantifiable performance metric, generating multiple design options for comparison.
- Interpret multi-objective optimization trade-offs (Pareto fronts) to select a justified design option from a generated set.
- Translate digital models into physical prototypes through CNC milling, laser cutting, 3D printing, and robotic-fabrication workflows, documenting file preparation and machine parameters.
- Build toward a cumulative BIM-software practicum deliverable through guided, certification-aligned exercises in parametric authoring and generative-design tools.

4. General Competences (*Outcomes*)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Usage)

AG-A09) Creates architectural designs that satisfy aesthetic and technical requirements. (Usage)

5. Content

5.1 Parametric Modeling and Visual Scripting for BIM, 24 hr(s)

Competences: AG-A06,AG-A07

Topics: **I:** Parametric family and component authoring: creating custom BIM families with parametric constraints, formulas, and type/instance parameters (Revit families, ArchiCAD GDL objects) **II:** Adaptive and generative components: adaptive component modeling for non-standard geometry, nested and shared parameters, and parametric array/pattern-based component placement **III:** Visual programming for BIM automation: Dynamo and Grasshopper-to-Revit workflows for geometry generation, data extraction, and model auditing **IV:** Integrating computational design with BIM: round-tripping geometry between parametric-design environments and BIM authoring tools, and managing model complexity and file size

Learning Outcomes **I:** Describe the difference between a standard BIM family or component and a parametric or adaptive one, and identify when visual scripting is an appropriate tool for a BIM modeling task [Familiarity] **II:** Author a parametric family or component with meaningful parametric constraints, and use a visual-scripting tool to automate a repetitive BIM modeling or data-extraction task [Usage] **III:** Evaluate a parametric BIM family or visual script for robustness, reusability, and appropriateness to the design problem it addresses [Assessment]

Bibliography: [Woodbury, 2010]

5.2 Generative Design and Optioneering, 24 hr(s)

Competences: AG-A07,AG-A09

Topics: **I:** Generating design option sets through parametric variation of a model's driving dimensions, and organizing them for systematic comparison **II:** Performance-driven generative design: coupling a parametric model to a fitness metric (area efficiency, daylight, structural weight) via optimization plug-ins (Galapagos, Octopus) **III:** Multi-objective optimization trade-offs: Pareto fronts for competing criteria, and interpreting optimization results for design decision-making

Learning Outcomes **I:** Describe how generative design couples a parametric model to a performance metric to produce and compare design options [Familiarity] **II:** Set up a parametric model and an optimization plug-in to generate a set of design options against a chosen performance metric [Usage] **III:** Evaluate a generative-design option set for the validity of its performance metric and the appropriateness of the selected design option [Assessment]

Bibliography: [Menges and Ahlquist, 2011]

5.3 Digital Fabrication Output and CNC Toolpaths, 24 hr(s)

Competences: AG-A06

Topics: **I:** CNC milling workflow: generating toolpaths from 3D models (roughing and finishing passes), selecting bits (end mill, ball nose), setting feeds and speeds, workpiece fixturing, **II:** Laser cutting workflow: preparing vector files (DXF, AI), setting cut vs. etch parameters by material type (plywood, acrylic, cardboard), kerf compensation, **III:** 3D printing workflow: STL/3MF file preparation, orientation for minimal supports, layer height, infill density, print bed adhesion, **IV:** Robotic fabrication basics: 6-axis robotic arm kinematics, toolpath generation (KUKA|prc, HAL for Grasshopper), end-effector design (spindle, extruder, gripper), **V:** Post-processing of digitally fabricated parts: removing supports, sanding, painting, assembly of modular components, and the relationship between fabrication tolerances

Learning Outcomes **I:** Describe the workflows for CNC milling, laser cutting, and 3D printing in architectural model-making and prototyping, including file preparation, machine parameter selection, [Familiarity] **II:** Generate toolpaths for a laser cutter or CNC router from a 3D model or 2D vector file, fabricate a physical prototype, and document the process [Usage] **III:** Evaluate the suitability of a digital fabrication method (CNC, laser, 3D print) for a specific architectural component or model, considering material, resolution, cost, [Assessment]

Bibliography: [Kolarevic, 2003]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: **I:** Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes **I:** Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Krygiel et al., 2023]

6. Bibliography

[Kolarevic, 2003] Kolarevic, B. (2003). *Architecture in the Digital Age: Design and Manufacturing*. Spon Press, 1st edition.

[Krygiel et al., 2023] Krygiel, E., Read, P., and Vandezande, J. (2023). *Mastering Autodesk Revit 2024*. Sybex, 1st edition.

[Menges and Ahlquist, 2011] Menges, A. and Ahlquist, S. (2011). *Computational Design Thinking*. Wiley, 1st edition.

[Woodbury, 2010] Woodbury, R. (2010). *Elements of Parametric Design*. Routledge, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1D2 Design Studio II (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR1D1 Design Studio I (1st Sem-Pg. 45)

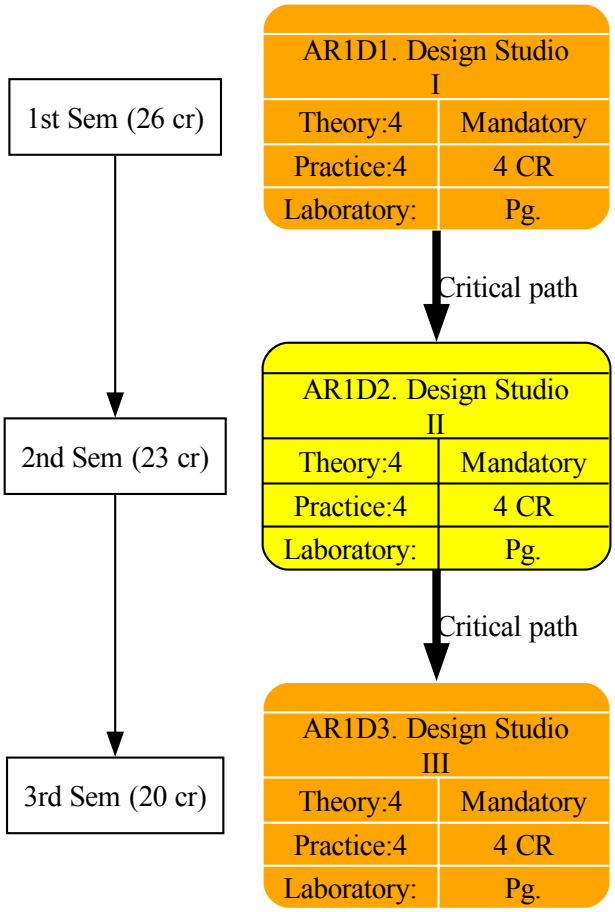


Figure 3.11: Connection Map. AR1D2 Design Studio II

2. Course Rationale

Design Studio II: Single-Family Housing is the student's first complete, habitable design project, building on the spatial, formal, and representational foundations developed in Design Studio I (AR1D1, prerequisite). Students design a single-family house on a real lot, resolving a full domestic program – living, sleeping, service, and outdoor spaces – while responding to accessibility requirements, daylight and thermal comfort, and the specific conditions of the site. The studio introduces the residential structural systems – confined masonry, timber framing, and reinforced adobe – most commonly used

to build a single-family house in Peru. It continues the pin-up/desk-crit critique culture and introduces the communication skills (design boards, physical models, verbal presentation) needed to defend a complete design proposal. This course is the foundation for Design Studio III (AR1D3).

3. Goals of the Course

- Apply human-centered and universal design principles – including accessibility standards – to the design of a complete domestic program on a real lot.
- Resolve the functional, spatial, and site-responsive requirements of single-family housing, from zoning diagrams to a developed floor plan.
- Design building apertures and envelope strategies that provide adequate daylight and passive thermal comfort for the dwelling.
- Select and detail an appropriate residential structural system – confined masonry, timber framing, or reinforced adobe – for the house, considering material availability, cost, and seismic performance.
- Iterate the design proposal through a full studio critique cycle and communicate the final design through boards, models, and verbal presentation.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)

AG-A11) Demonstrates knowledge of the physical problems and technologies that allow buildings to provide internal comfort and protection within environmental parameters. (Usage)

AG-A15) Understands the relationship between people, buildings, and their environment, and the need to relate buildings and spaces to human scale and needs. (Usage)

5. Content

5.1 Human-Centered and Inclusive Design, 8 hr(s)

Competences: AG-A15

Topics: **I:** Universal design principles: equitable use, flexibility in use, simple and intuitive operation, perceptible information, tolerance for error, low physical effort, and size **II:** Accessibility standards and codes: ADA, ISO 21542, and regional building codes for accessible routes, ramps, elevators, restrooms, signage, and emergency egress **III:** Spatial user experience: wayfinding, legibility, sensory richness, acoustic comfort, and the design of spaces that support diverse activities, ages, and abilities **IV:** Participatory design processes: engaging future users and communities in defining spatial needs; co-design workshops, interviews, and community mapping as design tools

Learning Outcomes **I:** Describe the principles of universal design and inclusive architecture and explain how they translate into spatial and technical design decisions [Familiarity] **II:** Apply universal design principles and accessibility standards to develop an architectural design that accommodates the full spectrum of human ability, age, and cultural background [Usage] **III:** Evaluate a building or public space design for inclusivity and accessibility, identifying barriers and proposing design modifications to improve equity and user experience [Assessment]

Bibliography: [Neufert and Neufert, 2012]

5.2 Residential and Vernacular Structural Systems, 8 hr(s)

Competences: AG-A08

Topics: **I:** Confined masonry (albañilería confinada): masonry walls confined by cast-in-place reinforced-concrete tie-columns and tie-beams, its seismic behavior and failure modes, and its role as Peru's dominant residential construction system under RNE Norma E.070 **II:** Timber structural systems: heavy-timber post-and-beam framing, light wood framing (platform framing), mass timber (CLT, glulam), and the connections that distinguish each system's load path and seismic behavior **III:** Reinforced and improved adobe (adobe mejorado): seismic retrofitting of earthen walls with geogrid/geomesh, cane (caña), or wire mesh reinforcement to mitigate the brittle failure of plain adobe, per Peru's RNE Norma E.080

Learning Outcomes **I:** Identify confined masonry, timber, and reinforced earthen construction as structural systems, and describe their seismic behavior, failure modes, and appropriate use contexts [Familiarity] **II:** Select and detail an appropriate residential structural system - confined masonry, timber framing, or reinforced adobe - for a single-family house, considering material availability, cost, and seismic performance [Usage] **III:** Evaluate a single-family house's structural system for seismic adequacy and constructability, identifying code-compliance gaps under RNE Norma E.070 or E.080 as applicable [Assessment]

Bibliography: [Friedman, 2013]

5.3 Housing and Residential Environments, 12 hr(s)

Competences: AG-A15

Topics: **I:** Housing typologies: single-family detached, row house, courtyard building, walk-up apartment, point tower, slab block, double-loaded corridor, **II:** Affordable housing strategies: inclusionary zoning, density bonuses, cross-subsidization, public-private partnerships, community land trusts (CLTs), and the financial **III:** Housing quality and dweller control: orientation for sunlight and ventilation, unit deepth to window ratio, privacy thresholds (distance to opposite windows), acoustic separation **IV:** Mixed-income and social mix housing: fostering social interaction, avoiding stigma of large public housing projects (Pruitt-Igoe lessons), **V:** Housing policy frameworks: Vienna's social housing model, Singapore's public housing, Chilean housing subsidies,

Learning Outcomes **I:** Identify the principal housing typologies and their urban density contributions, and describe the design qualities that distinguish high-quality residential environments from poorly designed ones [Familiarity] **II:** Design a housing block at the neighborhood scale, specifying building typology mix, dwelling unit orientation and ventilation strategy, [Usage] **III:** Evaluate a housing project for quality of life, affordability, and urban integration, using indicators such as floor-to-ceiling height, access to light [Assessment]

Bibliography: [Neufert and Neufert, 2012, Friedman, 2013]

5.4 Daylighting and Visual Comfort, 8 hr(s)

Competences: AG-A11

Topics: **I:** Daylight performance metrics: daylight factor (DF), spatial daylight autonomy (sDA), annual sunlight exposure (ASE), useful daylight illuminance (UDI), and glare indices (DGP, DGI) **II:** Aperture design for daylight: window-to-wall ratio (WWR), head height, sill height, clerestories, sawtooth roofs, light shelves, **III:** Shading integration for glare and cooling: fixed (overhangs, fins, louvers), operable (roller shades, venetian blinds, screens), **IV:** Daylight simulation tools: climate-based modeling (Radiance, DIVA, ClimateStudio, Ladybug Tools); annual simulation for LEED and other certification credits **V:** Electric lighting integration: daylight harvesting controls (dimming, stepped switching), task-ambient lighting strategies,

Learning Outcomes I: Describe the principal daylight performance metrics (sDA, ASE, UDI) and explain how they inform aperture and shading design decisions [Familiarity] **II:** Design and simulate a daylighting strategy for a building facade or roof aperture, iterating on WWR, orientation, and shading to meet defined sDA and ASE targets [Usage] **III:** Evaluate a building's daylighting design from simulation outputs, identifying areas of glare or insufficient illuminance [Assessment]

Bibliography: [Brown and DeKay, 2001]

5.5 Thermal Comfort and Passive Systems, 8 hr(s)

Competences: AG-A11

Topics: I: Heat transfer mechanisms in buildings: conduction through assemblies (U-value), convection at surfaces and within cavities, and long-wave **II:** Thermal comfort indices: PMV (predicted mean vote), PPD (predicted percentage dissatisfied), operative temperature, **III:** Passive solar heating: direct gain (south-facing glazing + thermal mass), indirect gain (Trombe wall, water wall), isolated gain (sunspace) **IV:** Passive cooling strategies: night-flush ventilation, radiative cooling to the night sky, earth coupling (earth tubes, berming), evaporative cooling (roof ponds, fountains), **V:** Thermal mass strategies: phase change materials (PCMs), exposed concrete or masonry for diurnal heat storage, and the placement of mass relative to insulation and solar gains

Learning Outcomes I: Describe the heat transfer mechanisms that affect building thermal performance and explain the difference between predicted mean vote (PMV) and adaptive thermal comfort models [Familiarity] **II:** Select and apply appropriate passive heating and cooling strategies for a building in a given climate, sizing apertures and mass to reduce predicted heating and cooling loads [Usage] **III:** Evaluate a building's thermal design using simulation or hand calculation, identifying strategies that are underperforming [Assessment]

Bibliography: [Brown and DeKay, 2001]

5.6 Design Process and Creative Methods, 10 hr(s)

Competences: AG-A04

Topics: I: Brief analysis and problem framing: decomposing a design brief into spatial, functional, contextual, and performative requirements; identifying constraints and opportunities **II:** Architectural site analysis: solar orientation and sun path, prevailing wind and microclimate, topography and drainage, views and visual axes, vehicular and pedestrian access, surrounding urban fabric and context, and existing site constraints (easements, setbacks, utilities) as inputs to a design concept **III:** Design-criteria formulation: translating client and user requirements, site-analysis findings, and regulatory constraints into a prioritized, measurable set of functional, spatial, environmental, and budgetary criteria used to generate and evaluate design alternatives **IV:** Ideation and concept development: sketching, diagramming, and collage as tools to explore spatial ideas; arriving at the parti (partido arquitectónico) – the single organizing idea that drives a design – and translating it into spatial and formal proposals **V:** Physical model-making as a design tool: study models for spatial exploration, massing studies, sectional models, and the role of making in discovering design solutions **VI:** Iterative design and critique: pin-up and desk critique culture, receiving and integrating feedback, revision cycles, and developing design judgment through reflection **VII:** Design narrative and argumentation: articulating design intent verbally and graphically, building a coherent design argument, and presenting spatial proposals persuasively **VIII:** Collaborative and interdisciplinary design processes: co-design with engineers, landscape architects, and community stakeholders

Learning Outcomes I: Describe the stages of an iterative architectural design process, from brief and site analysis through design-criteria formulation, concept development (parti), revision, and final proposal [Familiarity] **II:** Apply site analysis, design-criteria formulation, and systematic

ideation and iterative critique methods to develop and refine a spatial architectural proposal in response to a design brief [Usage] **III:** Evaluate the coherence and effectiveness of a design process, including the quality of concept articulation, iteration, and responsiveness to critique [Assessment]

Bibliography: [Lawson, 2005]

5.7 Architectural Communication and Presentation, 8 hr(s)

Competences: AG-A04

Topics: I: Design boards and panels: composition principles (grid, hierarchy, contrast, white space), integrating drawings (plan, section, elevation, axonometric, perspective), renderings **II:** Architectural portfolio design: project selection (range of scales, stages, typologies), portfolio structure, narrative, captioning, **III:** Physical model presentation: material choices (cardboard, foam, acrylic, 3D-printed, laser-cut), scale selection, level of detail, lighting **IV:** Verbal presentation of design: structuring a 5-10 minute design pitch (problem, concept, proposal, testing, conclusion), visual aids, responding to critique, **V:** Architectural diagramming: circulation, program, structure, environmental performance, form generation, process

Learning Outcomes I: Describe the key elements of effective architectural communication: narrative structure, visual hierarchy, appropriate level of detail, [Familiarity] **II:** Produce a design presentation board (single panel) for an architectural project that integrates orthographic drawings, rendered views, diagrams, [Usage] **III:** Evaluate a design portfolio or presentation for its communicative effectiveness, identifying strengths in narrative and visual clarity [Assessment]

Bibliography: [Ching, 2014]

6. Bibliography

[Brown and DeKay, 2001] Brown, G. Z. and DeKay, M. (2001). *Sun, Wind, and Light: Architectural Design Strategies*. Wiley, 2nd edition.

[Ching, 2014] Ching, F. D. K. (2014). *Architectural Graphics*. Wiley, 6th edition.

[Friedman, 2013] Friedman, A. (2013). *Fundamentals of Residential Construction*. Wiley, 3rd edition.

[Lawson, 2005] Lawson, B. (2005). *How Designers Think: The Design Process Demystified*. Architectural Press, 4th edition.

[Neufert and Neufert, 2012] Neufert, E. and Neufert, P. (2012). *Architects' Data*. Wiley-Blackwell, 4th edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2R1 Digital Drafting (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 2 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR1R1 Geometry and Analog Drawing (1st Sem-Pg. 49)

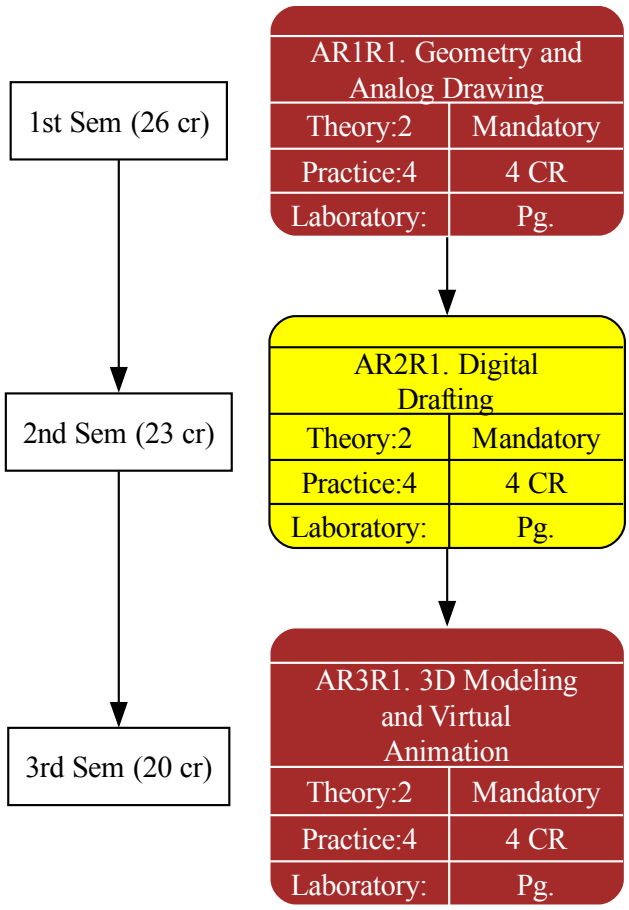


Figure 3.12: Connection Map. AR2R1 Digital Drafting

2. Course Rationale

Digital Drafting is the second step of the Representation sequence, building directly on the orthogonal-projection and drafting-convention foundations from Geometry and Analog Drawing I (ARC1R1) and translating them into professional CAD/BIM software (Civil 3D, BricsCAD BIM). It introduces layer management, parametric/visual scripting, and generative-AI-assisted ideation – the production pipeline every later urbanism studio and the Topography course (ARC1T1) will assume students already have. Dedicated BIM authoring is left to the BIM course sequence (AR1B1 onward), which this course precedes.

3. Goals of the Course

- Produce coordinated, layer-managed 2D technical drawings in CAD software for urban infrastructure, lots, and public-space plans.
- Build basic parametric/visual-scripting workflows to generate design variants of recurrent urban components (street sections, lot layouts).
- Use generative-AI tools for early-stage design ideation and image refinement, critically assessing their dimensional accuracy and authorship limitations against CAD-authored drawings.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Assessment)

5. Content

5.1 Computer-Aided Drafting (CAD), 32 hr(s)

Competences: AG-A04

Topics: **I:** Digital 2D drafting in CAD software: layer organization and naming conventions (AIA CAD Layer Guidelines, US National CAD Standard), line types and line weights managed by layer, blocks and symbols as reusable CAD objects, external references (Xrefs) for coordinating consultant drawings, and plotting and sheet setup

Learning Outcomes **I:** Identify the core conventions of digital 2D CAD drafting - layer organization, line types, blocks, and external references - and describe how they differ from hand-drafting conventions [Familiarity] **II:** Produce a set of 2D CAD drawings for a small building using organized layers, blocks, and a consistent plotting and sheet setup [Usage] **III:** Evaluate a set of CAD drawings for layer organization, line-type consistency, and block usage, identifying errors that would complicate plotting or consultant coordination [Assessment]

Bibliography: [Omura, 2022]

5.2 Parametric Design and Visual Programming, 32 hr(s)

Competences: AG-A06

Topics: **I:** Associative (parametric) modeling: defining geometry through relationships and rules rather than fixed coordinates; data flow graphs (inputs, components, outputs) **II:** Data types in parametric models: numbers (integers, floats), points, vectors, curves, surfaces, breps, lists, data trees (graft, flatten, simplify), **III:** Attractors and fields: using point attractors, curve attractors, or image sampling to modulate geometric parameters (size, rotation, density, offset) across a field **IV:** Parametric design families: creating a parameterized component (window, shading louver, structural node) whose geometry updates when driving dimensions or external data changes **V:** Integrating external data: reading data from CSV/Excel files to drive geometry (site sun hours, program areas, cost data)

Learning Outcomes **I:** Describe the principles of associative parametric modeling and explain the role of data trees, attractors, and external data in generating geometric variation [Familiarity] **II:** Develop a parametric definition for a building facade panel system or structural grid that varies by orientation or solar exposure [Usage] **III:** Evaluate a parametric definition for efficiency and clarity, identifying unnecessary components, redundant data structures, and opportunities for simplification or documentation [Assessment]

Bibliography: [Davidson, 2015]

5.3 Generative AI for Architectural Design, 32 hr(s)

Competences: AG-A06

Topics: **I:** Text-to-image generation for design ideation: prompt engineering (style descriptors, architectural typologies, atmospheric qualities), iterative refinement, **II:** Image-to-image and inpainting: using sketches or massing models as input for AI refinement (style transfer, detail generation) **III:** Emerging text-to-3D generation: generating 3D models (mesh, point cloud, NeRF) from text or image prompts **IV:** Integrating generative AI into architectural workflows: early concept generation, client mood boards, presentation image enhancement (style transfer, background replacement **V:** Limitations and risks of generative AI in architecture: lack of dimensional accuracy, non-constructible details, copyright

Learning Outcomes **I:** Describe the capabilities and limitations of generative AI (text-to-image, image-to-image, text-to-3D) for architectural design ideation and visual communication [Familiarity] **II:** Use a text-to-image AI tool to generate a set of conceptual design variations for an architectural project, then refine the best variation through image-to-image inpainting [Usage] **III:** Evaluate AI-generated design images for their applicability to a real design problem, distinguishing inspirational material from constructible design content, [Assessment]

Bibliography: [del Campo and Manninger, 2022]

6. Bibliography

[Davidson, 2015] Davidson, S. (2015). *Grasshopper: Visual Scripting for Rhinoceros 3D*. self-published / McNeel, 1st edition.

[del Campo and Manninger, 2022] del Campo, M. and Manninger, S. (2022). *Neural Architecture: Design and Artificial Intelligence*. ORO Editions, 1st edition.

[Omura, 2022] Omura, G. (2022). *Mastering AutoCAD Civil 3D*. Sybex, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

ID101 Technical and professional English I (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 2
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 2 hours;
- **Prerrequisites**: None

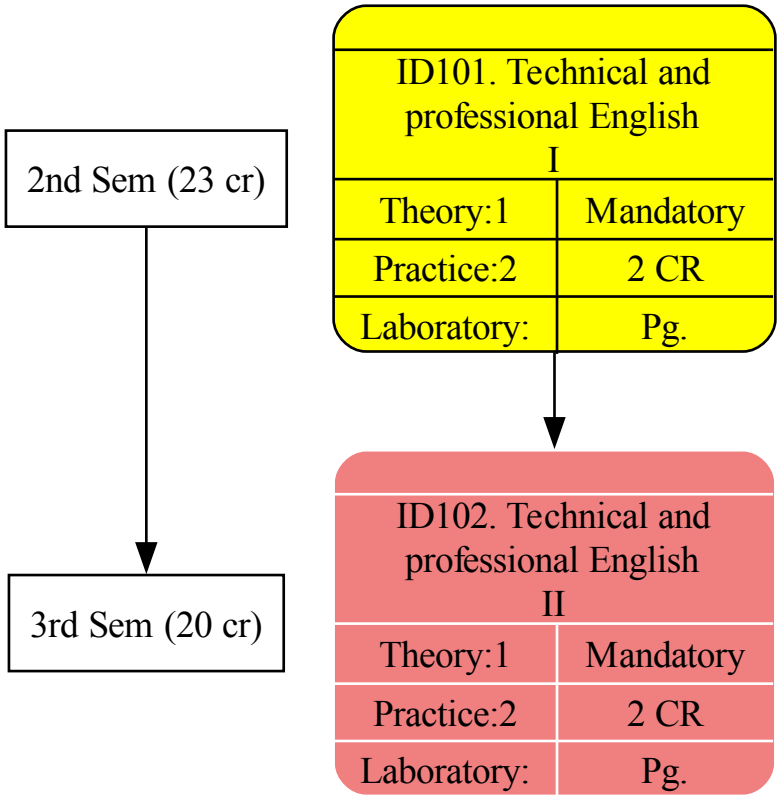


Figure 3.13: Connection Map. ID101 Technical and professional English I

2. Course Rationale

English is the primary language of science, engineering, and technology worldwide. For computing and engineering students, mastering English means gaining direct access to technical documentation, research papers, and professional collaboration without translation barriers. This course builds foundational English skills using contexts drawn from computing systems, hardware, and the everyday work of engineers and scientists.

3. Goals of the Course

- Acquire foundational English grammar structures applied to computing and engineering contexts.
- Identify and use technical vocabulary related to hardware, software, and scientific concepts.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

5. Content

5.1 Welcome to Computing, 12 hr(s)

Competences: AG-A04

Topics: I: Verb To Be: Affirmative, Negative, and Questions. **II:** Personal Pronouns and Possessive Adjectives. **III:** Number Expressions (1-100): Ports, addresses, and binary basics. **IV:** Social Expressions in academic and lab environments.

Learning Outcomes I: By the end of the unit, students use the verb 'to be' to introduce themselves as computing students and describe basic properties of computing systems (e.g., "The processor is fast. It is a 64-bit CPU.").

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.2 Parts and Systems, 12 hr(s)

Competences: AG-A04

Topics: I: Possessive 's and Plural Nouns applied to components (the CPU's speed, the system's memory). **II:** Hardware components and their relationships. **III:** Adjective + Noun structures for technical descriptions. **IV:** Lab interactions: Asking about equipment and tools.

Learning Outcomes I: Students describe computer hardware components and their relationships using possessives and noun phrases (e.g., "the motherboard's slots", "the server's processors").

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.3 How It Works, 12 hr(s)

Competences: AG-A04

Topics: I: Present Simple I (Third person: He/She/It) to describe processes. **II:** Vocabulary: How programs, algorithms, and devices operate. **III:** Telling the time and interpreting system clocks and schedules. **IV:** Verbs of operation: runs, compiles, executes, stores, transmits.

Learning Outcomes I: Students explain how a program or device works using the present simple in the third person (e.g., "The compiler translates source code. It generates an executable file.").

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.4 What Engineers Do, 12 hr(s)

Competences: AG-A04

Topics: I: Present Simple II (I/You/We/They) for describing professional routines. **II:** Questions and negatives with 'Do/Does' in technical contexts. **III:** Engineering roles: developer, analyst, researcher, systems engineer. **IV:** Adverbs of frequency in describing work cycles and testing schedules.

Learning Outcomes I: Students describe the daily tasks and professional roles of computing engineers and scientists using the present simple with accuracy.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.5 Inside a Computer, 12 hr(s)

Competences: AG-A04

Topics: I: Existential: There is / There are applied to architecture descriptions. **II:** Prepositions of place: components on a motherboard, files in a directory. **III:** Vocabulary: memory, storage, buses, slots, ports, layers. **IV:** Describing network topology and physical infrastructure.

Learning Outcomes I: Students describe the spatial organization of hardware components and file systems, enabling them to interpret and produce technical architecture descriptions.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.6 Can Computers Think?, 12 hr(s)

Competences: AG-A04

Topics: I: Modal verb Can/Can't to describe computing capabilities and limitations. **II:** Adverbs of manner applied to system performance. **III:** Past of verb 'To Be' (Was/Were): early computing systems and pioneers. **IV:** Basic expressions for technical support and troubleshooting.

Learning Outcomes I: Students describe what computing systems can and cannot do, and identify basic facts about the early history of computing using simple past structures.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.7 Computing History, 12 hr(s)

Competences: AG-A04

Topics: I: Past Simple: Regular and Irregular verbs to narrate tech history. **II:** Time expressions for the past: invented, developed, published, launched. **III:** Key figures: Turing, Babbage, Lovelace, von Neumann. **IV:** Vocabulary: Generations of computers, milestones, inventions.

Learning Outcomes I: Students narrate key events in the history of computing and science using the simple past correctly, identifying the contributions of foundational figures.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.8 My Professional Goals in Computing, 12 hr(s)

Competences: AG-A04

Topics: I: Introduction to Technical English for Computing and Engineering. **II:** Reading and understanding simple technical specifications. **III:** Working in multicultural engineering teams: communication norms. **IV:** Oral presentation: "My role in the computing field".

Learning Outcomes I: Students present their professional goals in computing using basic technical vocabulary and connect them to the roles and responsibilities of software and hardware engineers.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

6. Bibliography

[Cambridge, 2006] Cambridge (2006). *Diccionario Inglés-Espanol Cambridge*. Editorial Oxford.

[MacGrew, 1999] MacGrew, J. (1999). *Focus on Grammar Basic*. Editorial Oxford.

[Soars and John, 2002d] Soars, L. and John (2002d). *American Headway N 2 Student Book*. Editorial Oxford.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG263 Communication II (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 4 hours;
- **Prerrequisites**:
  - EG163 Communication I (1st Sem-Pg. 56)

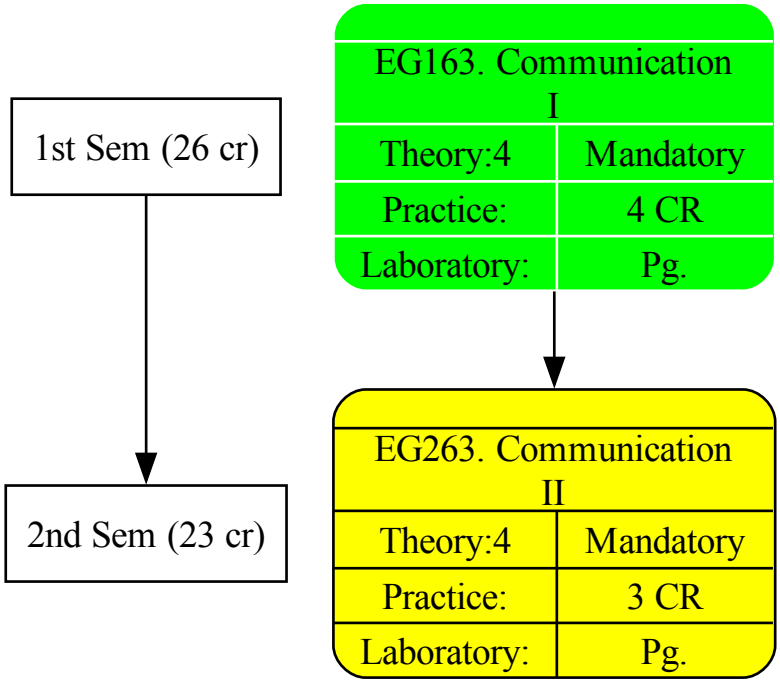


Figure 3.14: Connection Map. EG263 Communication II

2. Course Rationale

Comunicación II es el segundo curso de la línea de comunicación del Área de Estudios Generales, de naturaleza teórico-práctica y carácter obligatorio. Tiene como propósito el fortalecimiento de la competencia comunicativa de los estudiantes mediante la comprensión, producción y comunicación oral y escrita de discursos académicos de acuerdo con su especialidad. Comprende el texto lingüístico (estructura y redacción), los documentos académicos y el artículo académico, los principios básicos de la redacción (coherencia y cohesión), el proceso de producción escrita (planificación, textualización y revisión), el ensayo académico y las normas APA para citas y referencias.

3. Goals of the Course

- Aplicar estrategias lectoras en resúmenes y textos con contenido temático relacionado con la carrera profesional.

- Utilizar las técnicas de redacción de un texto académico, articulando documentos escritos en diversos contextos académicos y científicos.
- Producir un ensayo académico aplicando los procesos de planificación, textualización y revisión, con normas APA.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Usage)

5. Content

5.1 El Texto Lingüístico: Estructura y Redacción, 20 hr(s)

Competences: AG-A04

Topics: **I:** El texto lingüístico. Niveles del texto: macroestructura, microestructura y superestructura. Características de la redacción. **II:** Los documentos académicos. El artículo académico: modalidades, estructura, elementos. **III:** Principios básicos de la redacción: coherencia y cohesión. Comprensión de textos académicos: ideas principales y secundarias. **IV:** El léxico académico y sus características. Estrategias para la elaboración de resúmenes académicos. **V:** La redacción científica. El proceso de producción escrita: planificación, textualización, revisión.

Learning Outcomes **I:** Identifica y analiza la macroestructura, microestructura y superestructura de textos lingüísticos relacionados con su carrera profesional. [Usage]. **II:** Reconoce los documentos académicos e identifica las modalidades, estructura y elementos del artículo académico. [Usage]. **III:** Identifica las ideas principales y secundarias, y aplica elementos de coherencia y cohesión en la producción de un artículo académico breve. [Usage]. **IV:** Selecciona y organiza las ideas principales y secundarias de un texto académico, elaborando un resumen relacionado con su carrera profesional. [Usage].

Bibliography: [Aguirre et al., 2014, Bernal, 2007]

5.2 Los Procesos de Escritura de un Texto Académico, 28 hr(s)

Competences: AG-A10

Topics: **I:** El ensayo: características, clases y estructura. El proceso de producción del ensayo: planificación, textualización, revisión. **II:** Proceso de redacción: planificación individual del ensayo. Análisis de la necesidad comunicativa, investigación, comprensión y selección de información. Organización de la información, tesis y argumentos. **III:** Recursos para la redacción académica: citas, datos, ejemplos, definiciones, paráfrasis. Ética en la producción de textos: reconocimiento de la autoría, uso responsable de fuentes y prevención del plagio. Normas APA. **IV:** Proceso de redacción: textualización. El párrafo: características y clasificación. Principios básicos de la redacción: cohesión y coherencia. **V:** Evaluación y cierre: revisión del ensayo académico considerando coherencia, cohesión, uso ético de fuentes y normas APA.

Learning Outcomes **I:** Caracteriza y reconoce las clases y estructura del ensayo, identificando los procesos de su producción escrita. [Usage]. **II:** Planifica el ensayo académico, formulando su esquema de redacción y aplicando estrategias para garantizar la adecuación y coherencia. [Usage]. **III:** Selecciona y utiliza fuentes académicas, incorporando citas y paráfrasis de manera ética y respetando la autoría mediante la aplicación de las normas APA. [Usage]. **IV:** Identifica y aplica los distintos tipos de párrafo, y los elementos de cohesión y coherencia, en el ensayo que está produciendo. [Usage]. **V:** Revisa y mejora el ensayo académico considerando criterios de coherencia, cohesión, uso ético de fuentes y normas APA. [Assessment].

Bibliography: [American Psychological Association, 2019, Maldonado, 2022]

5.3 El Ensayo Académico: Redacción y Presentación, 24 hr(s)

Competences: AG-A04

Topics: **I:** Proceso de redacción: textualización. El párrafo de desarrollo: características y clasificación. **II:** Pertinencia y solidez: la argumentación. Producción del artículo académico. **III:** Las estrategias argumentativas. Contraargumentación y concesión. **IV:** El párrafo de cierre: características y clasificación. **V:** Proceso de redacción: revisión y presentación del ensayo académico.

Learning Outcomes **I:** Aplica estrategias y recursos de textualización en la redacción del cuerpo del ensayo académico. [Usage]. **II:** Analiza y aplica criterios de pertinencia y solidez en la textualización de documentos académicos, planificando y redactando un artículo académico relacionado con la arquitectura y el urbanismo. [Usage]. **III:** Identifica las estrategias argumentativas y desarrolla la argumentación y contraargumentación que necesita el ensayo. [Usage]. **IV:** Identifica y aplica las características y los tipos de párrafo en la redacción del cierre del ensayo. [Usage]. **V:** Aplica estrategias de revisión y presenta el ensayo académico realizando las correcciones y modificaciones pertinentes. [Assessment].

Bibliography: [Aguirre et al., 2014, Núñez, 2016]

6. Bibliography

[Aguirre et al., 2014] Aguirre, M., Maldonado, C., Peña, C., and Rider, C. (2014). *Cómo Leer y Escribir en la Universidad: Cuaderno de Trabajo*. Editorial UPC.

[American Psychological Association, 2019] American Psychological Association (2019). *Manual de Estilo de Publicaciones de la APA*. Editorial El Manual Moderno.

[Bernal, 2007] Bernal, L. (2007). *Manual de Lectura y Redacción*. Editorial Politécnico Grancolombiano, 2nd edition.

[Maldonado, 2022] Maldonado, F. X. J. (2022). *Búsquedas Efectivas y Aplicación de Normas APA*. Editorial Exced, 7th edition.

[Núñez, 2016] Núñez, J. (2016). *Escritura Académica: De la Teoría a la Práctica*. Ediciones Pirámide.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG264 Philosophy (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

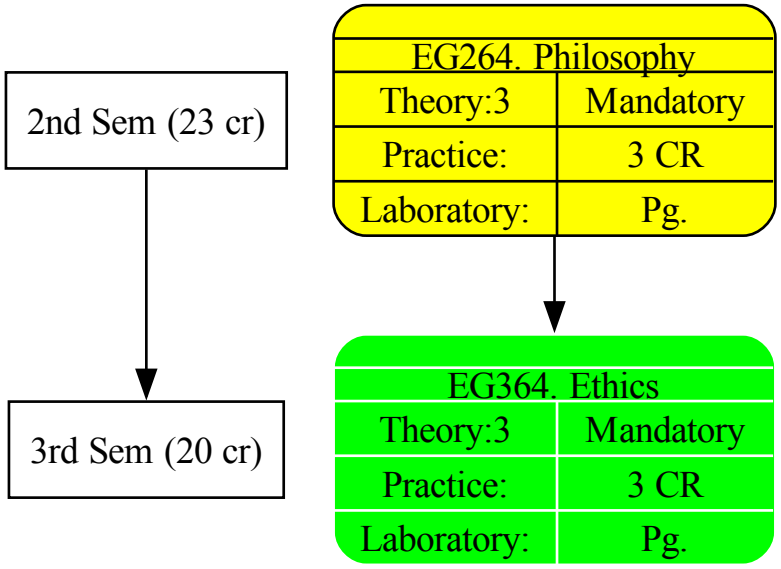


Figure 3.15: Connection Map. EG264 Philosophy

2. Course Rationale

Filosofía pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito desarrollar la reflexión y el juicio crítico, así como el interés ante los diversos problemas del mundo, del hombre y de la vida que se han presentado al pensamiento humano, mediante el análisis de las posiciones y teorías de los filósofos a través del tiempo y la expresión de puntos de vista propios. Comprende el origen de la filosofía, sus disciplinas, la filosofía griega y sus filósofos, la filosofía cristiana y la escolástica, el problema del conocimiento en la edad moderna (racionalismo, empirismo, criticismo), la filosofía política moderna, y la filosofía contemporánea, latinoamericana y peruana.

3. Goals of the Course

- Identificar las disciplinas filosóficas y los filósofos más representativos de la filosofía antigua y media, y su trascendencia hasta la actualidad.
- Reflexionar críticamente en torno al problema del conocimiento y la filosofía política en la época moderna.
- Reflexionar críticamente sobre la filosofía contemporánea, latinoamericana y peruana, y su relación con los problemas sociales y políticos.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Familiarity)

AG-A02) Applies ethical principles and the standards of professional architectural practice, respecting the legal framework and human diversity. (Familiarity)

5. Content

5.1 Filosofía Antigua y Media, 15 hr(s)

Competences: AG-A02

Topics: **I:** Origen de la filosofía: naturaleza y método, condiciones para su surgimiento, actitudes humanas. ¿Qué es la filosofía? **II:** Disciplinas filosóficas: ontología, antropología, gnoseología, epistemología, axiología, ética, estética. **III:** Filosofía griega: características, etapas, filósofos y legado. **IV:** Filósofos y su trascendencia: Sócrates, Platón, Aristóteles. **V:** Filosofía media: características, la escolástica y sus filósofos.

Learning Outcomes **I:** Analiza las condiciones del surgimiento, el concepto de filosofía y las actitudes humanas. [Familiarity]. **II:** Identifica las disciplinas filosóficas (ontología, antropología, gnoseología, epistemología, axiología, ética, estética) y su importancia. [Familiarity]. **III:** Describe aspectos importantes de la filosofía griega y analiza su trascendencia en la actualidad. [Familiarity]. **IV:** Identifica a los filósofos más representativos (Sócrates, Platón, Aristóteles) y su importancia hasta la actualidad. [Familiarity]. **V:** Identifica y analiza aspectos importantes de la filosofía media (escolástica y sus filósofos). [Familiarity].

Bibliography: [Delgado, 2021, Pastor, 2010]

5.2 Filosofía Moderna, 21 hr(s)

Competences: AG-A01

Topics: **I:** Filosofía moderna: el problema del conocimiento, el racionalismo, el empirismo, el criticismo. **II:** La filosofía política en la edad moderna: características y filósofos (Maquiavelo, Thomas Hobbes, John Locke). **III:** El problema histórico social. La importancia de los ODS para las universidades. **IV:** El problema del conocimiento: posibilidad, origen y esencia. **V:** El problema de la ciencia. El problema del hombre y de la vida.

Learning Outcomes **I:** Identifica, analiza y reflexiona sobre aspectos importantes de la filosofía moderna llevados al problema contemporáneo (el problema del conocimiento: racionalismo, empirismo, criticismo). [Usage]. **II:** Identifica y analiza aspectos importantes de la filosofía política en la edad moderna, según los filósofos de la época (Maquiavelo, Thomas Hobbes, John Locke). [Usage]. **III:** Analiza el problema histórico social desde el punto de vista de la filosofía, y la importancia de los ODS para las universidades desde el punto de vista ético. [Usage]. **IV:** Analiza el problema del conocimiento (posibilidad, origen y esencia) a través de trabajos grupales. [Usage]. **V:** Analiza el problema de la ciencia, y el problema del hombre y de la vida, a través de trabajos grupales e individuales. [Usage].

Bibliography: [Santacruz, 2005, Mendoza, 2012]

5.3 Filosofía Contemporánea, 18 hr(s)

Competences: AG-A01

Topics: **I:** Filosofía contemporánea: contexto y corrientes filosóficas. **II:** Filosofía en el Perú: aspectos resaltantes y trascendencia. **III:** Filosofía en Latinoamérica: aspectos resaltantes y trascendencia. **IV:** Corrientes filosóficas latinoamericanas de las últimas décadas del siglo XX y su relación con los problemas sociales y políticos.

Learning Outcomes I: Analiza e identifica los aspectos importantes de la filosofía contemporánea: contexto y corrientes filosóficas, a través de organizadores grupales y exposición. [Usage]. **II:** Identifica los aspectos resaltantes de la filosofía en el Perú y su trascendencia, a través de monografías/ensayos grupales y exposiciones. [Usage]. **III:** Identifica los aspectos resaltantes de la filosofía en Latinoamérica y su trascendencia. [Usage]. **IV:** Reflexiona críticamente sobre la filosofía latinoamericana de las últimas décadas del siglo XX y su relación con los problemas sociales y políticos. [Usage].

Bibliography: [Lago, 2023, Castro, 2013]

6. Bibliography

[Castro, 2013] Castro, A. (2013). *La Filosofía Entre Nosotros: Cinco Siglos de Filosofía en el Perú*. Fondo Editorial de la Pontificia Universidad Católica del Perú.

[Delgado, 2021] Delgado, W. B. (2021). *¿Qué es Filosofía?* Programa Editorial Universidad del Valle.

[Lago, 2023] Lago, M. B. (2023). *Cinco Estudios de Filosofía Contemporánea*. J.M. Bosch Editor, 1st edition.

[Mendoza, 2012] Mendoza, D. L. C. (2012). *Filosofía Moderna: Los Principales Autores de Esta Época*. El Cid Editor.

[Pastor, 2010] Pastor, W. F. (2010). *Filosofía Antigua*. Firmas Press.

[Santacruz, 2005] Santacruz, V. S. (2005). *De Descartes a Kant: Historia de la Filosofía Moderna*. EUNSA, 3rd edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG265 Peruvian Territory. National Defense and Security (Mandatory)

1. General information

- **Semester**: 2nd Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

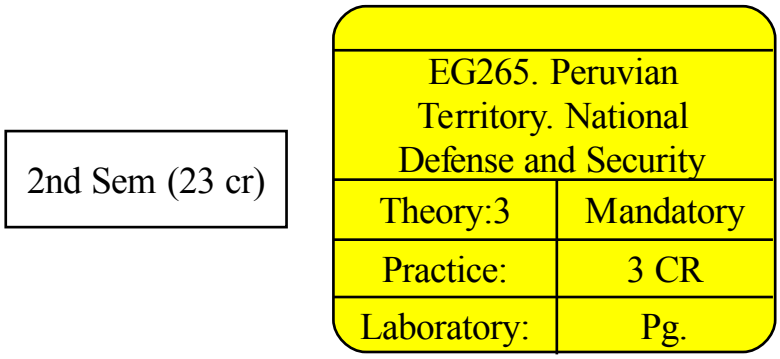


Figure 3.16: Connection Map. EG265 Peruvian Territory. National Defense and Security

2. Course Rationale

Territorio Peruano. Defensa y Seguridad Nacional pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito la comprensión de la realidad geográfica del Perú, reconociendo sus particularidades, así como el sistema de seguridad y defensa nacional, de modo que el estudiante adquiera conocimientos sobre la realidad socioeconómica y socio-cultural de su comunidad, región y del ámbito nacional. Comprende la geografía del Perú y sus pisos ecológicos, el Estado peruano y la constitución política, los principios y valores de la persona humana, la responsabilidad social, la corrupción y sus causas, y el sistema de defensa nacional y defensa civil.

3. Goals of the Course

- Analizar las principales características del territorio peruano, sus recursos naturales y la importancia de la geografía y los ODS en el Perú.
- Analizar a la persona humana y su relación con la constitución política del Perú, la responsabilidad social y la problemática de la corrupción.
- Analizar la importancia de la seguridad y la defensa nacional del Perú.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Usage)

AG-A02) Applies ethical principles and the standards of professional architectural practice, respecting the legal framework and human diversity. (Familiarity)

5. Content

5.1 Estado y Geografía del Perú, 15 hr(s)

Competences: AG-A01

Topics: **I:** El Estado peruano: concepto, origen, funciones, fines. La nación. La constitución política. Poderes del Estado. **II:** Escuelas geográficas: determinismo, posibilismo, geografía cuantitativa, geografías radicales, geografía sistémica. Divisiones de la geografía física y humana. **III:** La geografía del Perú: los pisos ecológicos, la biodiversidad, la cordillera de los Andes y la situación geopolítica del Perú en América Latina. **IV:** Los Objetivos de Desarrollo Sostenible: importancia, características, objetivos y contexto actual.

Learning Outcomes **I:** Describe aspectos importantes del Estado peruano y analiza la importancia de la constitución política del Perú. [Familiarity]. **II:** Identifica las escuelas geográficas para su mejor comprensión y analiza las divisiones de la geografía contextualizándolas en su territorio. [Familiarity]. **III:** Comprende la influencia de la cordillera de los Andes y analiza la situación geopolítica del Perú en América Latina. [Familiarity]. **IV:** Identifica la importancia de los Objetivos de Desarrollo Sostenible. [Familiarity].

Bibliography: [Arroyo, 2013, Asociación Fondo de Investigadores y Editores, 2017]

5.2 La Persona Humana, 21 hr(s)

Competences: AG-A02

Topics: **I:** Principios y valores de la persona humana: concepto, valores fundamentales (libertad, justicia, verdad, solidaridad, respeto, responsabilidad), principios éticos universales. **II:** Defensa de la persona humana: el papel del Estado, organismos internacionales y defensa de los derechos humanos, casos de violación de la dignidad humana. **III:** Fundamentos de la responsabilidad social: definición y evolución, responsabilidad social empresarial vs. responsabilidad social universitaria. **IV:** Concepto y tipología de la corrupción: soborno, malversación de fondos, colusión, tráfico de influencias, nepotismo, fraude electoral, enriquecimiento ilícito. **V:** Causas de la corrupción en el Perú: consecuencias en la economía, política y sociedad. Índice de Percepción de la Corrupción.

Learning Outcomes **I:** Identifica y analiza los principios y valores de la persona a través de trabajos grupales y exposiciones. [Usage]. **II:** Identifica y analiza aspectos importantes de la defensa de la persona en la sociedad actual, incluyendo organismos internacionales y casos de violación de la dignidad humana. [Usage]. **III:** Analiza la importancia de la responsabilidad social y universitaria en su localidad. [Usage]. **IV:** Analiza el problema de la corrupción en nuestra sociedad: definición y tipología. [Usage]. **V:** Analiza e identifica las causas de la corrupción en el Perú, sus consecuencias en la economía, la política y la sociedad. [Usage].

Bibliography: [Santiago, 2023, Quiroz, 2019]

5.3 Defensa y Seguridad Nacional, 18 hr(s)

Competences: AG-A01

Topics: **I:** La defensa nacional: objetivos, identidad nacional, defensa interna y externa. **II:** Sistema de Defensa Nacional: ámbitos, fundamentos, niveles, funciones, estructura y planeamiento estratégico. Movilización nacional y defensa civil. **III:** La seguridad integral y la defensa nacional. Relación entre el pueblo, el territorio y el poder. Expresiones del poder nacional. **IV:** Sistema de Defensa Civil: características, fase e importancia de la movilización nacional.

Learning Outcomes **I:** Analiza e identifica los aspectos importantes de la defensa nacional, a través de organizadores grupales y exposición. [Usage]. **II:** Identifica los aspectos resaltantes del Sistema de Defensa Nacional del Perú: ámbitos, fundamentos, niveles, funciones, estructura y planeamiento estratégico. [Usage]. **III:** Identifica los aspectos resaltantes de la seguridad

integral y la defensa nacional, y su trascendencia. [Usage]. **IV:** Reflexiona sobre el sistema de defensa civil y su relación con los problemas sociales y políticos. [Usage].

Bibliography: [Gob, , Mil,]

6. Bibliography

[Mil,] Día de la defensa nacional. Marina de Guerra del Perú, Mil.pe.

[Gob,] Sistema de defensa nacional. Gob.pe.

[Arroyo, 2013] Arroyo, C. L. (2013). *Constitución Política del Perú 1993: Sumillas, Reformas Constitucionales, Índice Analítico*. Fondo Editorial de la Pontificia Universidad Católica del Perú, 8th edition.

[Asociación Fondo de Investigadores y Editores, 2017] Asociación Fondo de Investigadores y Editores (2017). *Geografía Sociedad y Naturaleza*. Asociación Fondo de Investigadores y Editores, 1st edition.

[Quiroz, 2019] Quiroz, A. W. (2019). *Historia de la Corrupción en el Perú*. IEP Ediciones, 3rd edition.

[Santiago, 2023] Santiago, A. (2023). *La Dignidad de la Persona Humana: Fundamento del Orden Jurídico Nacional e Internacional*. Editorial Ábaco, 2nd edition.

Third Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1D3 Design Studio III (Mandatory)

1. General information

- **Semester**: 3rd Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR1D2 Design Studio II (2nd Sem-Pg. 72)

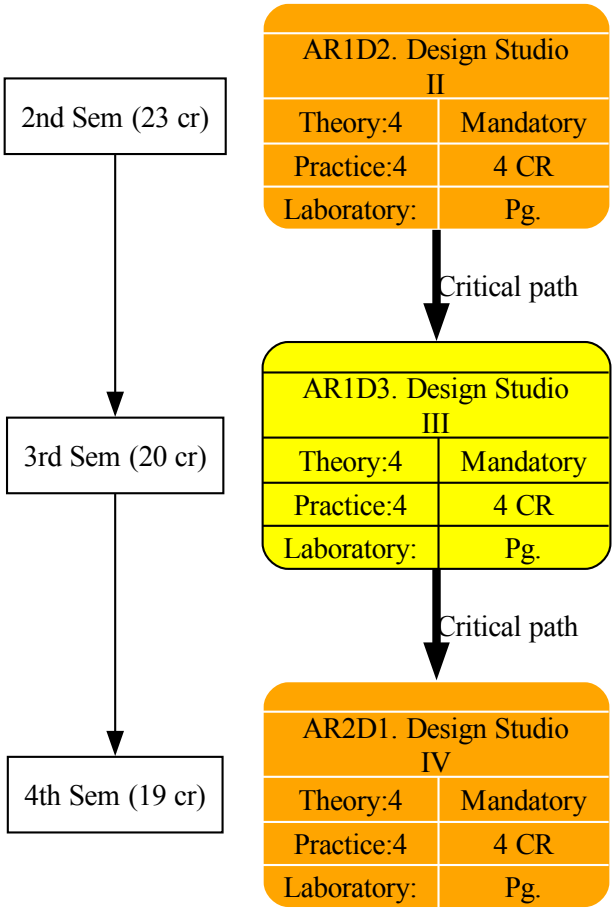


Figure 3.17: Connection Map. AR1D3 Design Studio III

2. Course Rationale

Design Studio III: Collective Housing moves the student from the single dwelling designed in Design Studio II (AR1D2, prerequisite) to medium-density collective housing. Students explore housing typologies – blocks, duplexes, row houses – and the relationship between the individual unit, the building, and shared community space. The studio places particular emphasis on the lateral structural

systems that medium-density housing requires, and on designing equitably for the social diversity of a collective housing community. This course is the foundation for Design Studio IV (AR2D1), which introduces the program's first public building typology.

3. Goals of the Course

- Design housing units within medium-density typologies (blocks, duplexes, row houses) and organize them into a coherent building and urban fabric.
- Analyze and apply urban morphology concepts – street, block, and plot systems – to the siting of a collective housing project.
- Design the lateral load-resisting system (moment frames, braced frames, shear walls) and coordinate it with the floor diaphragm, appropriate to a medium-density housing building.
- Apply equity, accessibility, and gender-sensitive design principles to the design of shared community space within the housing project.

4. General Competences (*Outcomes*)

AG-A02) Applies ethical principles and the standards of professional architectural practice, respecting the legal framework and human diversity. (Usage)

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)

AG-A15) Understands the relationship between people, buildings, and their environment, and the need to relate buildings and spaces to human scale and needs. (Usage)

5. Content

5.1 Housing and Residential Environments, 12 hr(s)

Competences: AG-A15

Topics: **I:** Housing typologies: single-family detached, row house, courtyard building, walk-up apartment, point tower, slab block, double-loaded corridor, **II:** Affordable housing strategies: inclusionary zoning, density bonuses, cross-subsidization, public-private partnerships, community land trusts (CLTs), and the financial **III:** Housing quality and dweller control: orientation for sunlight and ventilation, unit deepth to window ratio, privacy thresholds (distance to opposite windows), acoustic separation **IV:** Mixed-income and social mix housing: fostering social interaction, avoiding stigma of large public housing projects (Pruitt-Igoe lessons), **V:** Housing policy frameworks: Vienna's social housing model, Singapore's public housing, Chilean housing subsidies,

Learning Outcomes **I:** Identify the principal housing typologies and their urban density contributions, and describe the design qualities that distinguish high-quality residential environments from poorly designed ones [Familiarity] **II:** Design a housing block at the neighborhood scale, specifying building typology mix, dwelling unit orientation and ventilation strategy, [Usage] **III:** Evaluate a housing project for quality of life, affordability, and urban integration, using indicators such as floor-to-ceiling height, access to light [Assessment]

Bibliography: [Schneider and Till, 2007]

5.2 Urban Form and Morphology, 10 hr(s)

Competences: AG-A15

Topics: **I:** Kevin Lynch's city image elements: paths, edges, districts, nodes, and landmarks; their role in legibility and wayfinding; application to urban design analysis and intervention **II:** Street, block, and plot systems: typologies (grid, radial, organic, cul-de-sac), block dimensions and permeability, plot subdivision, **III:** Urban building typologies: single-family detached, row house (townhouse), courtyard building, slab, point tower, and linear block **IV:** Morphological

analysis methods: Conzenian (burgage cycle, fringe belts), space syntax (integration, connectivity, choice), and figure-ground diagrams for reading urban form **V:** Urban fabric layers: plot subdivision history, street network evolution, land use succession, and the persistence of plot boundaries over centuries as a design constraint

Learning Outcomes **I:** Identify the key morphological elements of a city - streets, blocks, plots, buildings - and describe the relationships among them that define urban character [Familiarity] **II:** Apply morphological analysis tools (figure-ground, space syntax) to an urban sector, identifying its legibility, connectivity, and typological diversity [Usage] **III:** Evaluate the morphological coherence and permeability of a proposed urban design, comparing block sizes, street connectivity, [Assessment]

Bibliography: [Kropf, 2017]

5.3 Human-Centered and Inclusive Design, 8 hr(s)

Competences: AG-A15

Topics: **I:** Universal design principles: equitable use, flexibility in use, simple and intuitive operation, perceptible information, tolerance for error, low physical effort, and size **II:** Accessibility standards and codes: ADA, ISO 21542, and regional building codes for accessible routes, ramps, elevators, restrooms, signage, and emergency egress **III:** Spatial user experience: wayfinding, legibility, sensory richness, acoustic comfort, and the design of spaces that support diverse activities, ages, and abilities **IV:** Participatory design processes: engaging future users and communities in defining spatial needs; co-design workshops, interviews, and community mapping as design tools

Learning Outcomes **I:** Describe the principles of universal design and inclusive architecture and explain how they translate into spatial and technical design decisions [Familiarity] **II:** Apply universal design principles and accessibility standards to develop an architectural design that accommodates the full spectrum of human ability, age, and cultural background [Usage] **III:** Evaluate a building or public space design for inclusivity and accessibility, identifying barriers and proposing design modifications to improve equity and user experience [Assessment]

Bibliography: [Neufert and Neufert, 2012]

5.4 Lateral Load-Resisting Systems, 10 hr(s)

Competences: AG-A08

Topics: **I:** Horizontal load-resisting systems: moment-resisting frames (rigid connections), braced frames (concentric, eccentric), shear walls (concrete, plywood, CLT), **II:** Floor and roof diaphragms: rigid vs. flexible diaphragm behavior, chord forces, collector elements, and load transfer from diaphragms to vertical lateral-resisting elements

Learning Outcomes **I:** Identify the primary lateral load-resisting systems - moment frames, braced frames, shear walls - and describe the role of floor and roof diaphragms in transferring lateral loads to them [Familiarity] **II:** Select and configure an appropriate lateral load-resisting system - moment frame, braced frame, or shear wall - for a mid-rise collective-housing building, coordinating it with the floor diaphragm [Usage] **III:** Evaluate a mid-rise building's lateral system for configuration irregularities (soft stories, torsional irregularities) and diaphragm continuity [Assessment]

Bibliography: [Schierle, 2012]

5.5 Social Equity and Inclusive Urbanism, 8 hr(s)

Competences: AG-A02

Topics: **I:** Spatial justice frameworks: Fainstein's just city (democracy, equity, diversity), Soja's seeking spatial justice, **II:** Gentrification and displacement: stages of gentrification, direct and indirect displacement (exclusionary displacement), anti-displacement strategies (rent control **III:** Participatory planning and community engagement: Arnstein's ladder of participation (manipulation to citizen control), deliberative methods (planning cell, consensus conference **IV:** Equitable transportation: transit deserts, fare equity, accessibility for persons with disabilities, safe routes for walking and cycling, **V:** Gender-inclusive urbanism: safety audits, lighting and sightlines for perceived safety, access to childcare facilities,

Learning Outcomes **I:** Identify the main dimensions of spatial justice - distribution, procedure, recognition - and describe how urban planning decisions can produce or mitigate inequitable outcomes [Familiarity] **II:** Apply an equity assessment tool (e.g., equity scorecard, health impact assessment) to an urban development proposal, identifying which populations benefit [Usage] **III:** Evaluate a participatory planning process for authenticity, power-sharing, and representation, recommending changes to increase meaningful participation of marginalized [Assessment]

Bibliography: [Fainstein, 2010]

6. Bibliography

[Fainstein, 2010] Fainstein, S. S. (2010). *The Just City*. Cornell University Press.

[Kropf, 2017] Kropf, K. (2017). *The Handbook of Urban Morphology*. Wiley.

[Neufert and Neufert, 2012] Neufert, E. and Neufert, P. (2012). *Architects' Data*. Wiley-Blackwell, 4th edition.

[Schierle, 2012] Schierle, G. G. (2012). *Architectural Structures*. University of Southern California.

[Schneider and Till, 2007] Schneider, T. and Till, J. (2007). *Flexible Housing*. Architectural Press.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2B1 Multidisciplinary Coordination (Mandatory)

1. General information

- **Semester**: 3rd Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR1B2 Parametric Modeling and Generative Design (2nd Sem-Pg. 68)

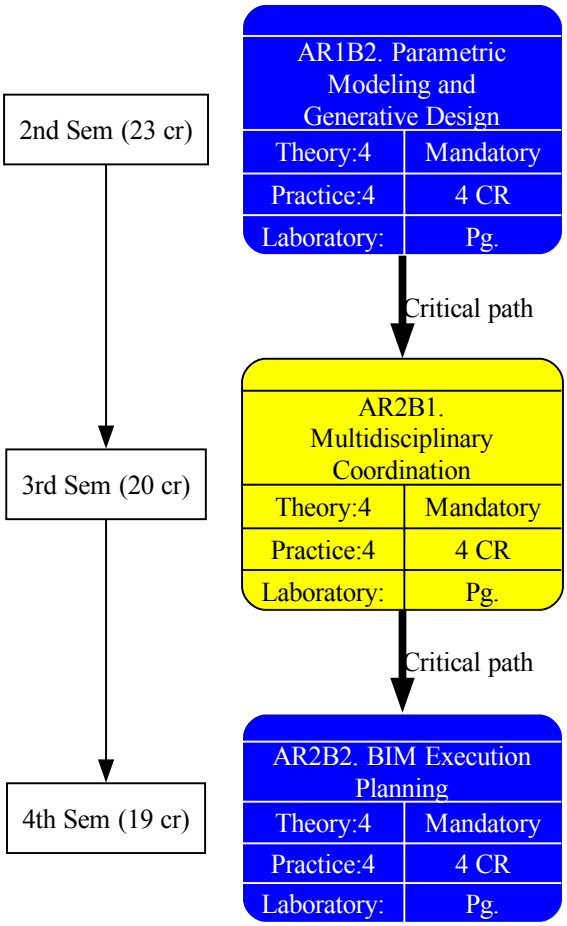


Figure 3.18: Connection Map. AR2B1 Multidisciplinary Coordination

2. Course Rationale

Multidisciplinary Coordination is the third course of the ten-course BIM I-X sequence, building directly on the parametric modeling and generative design skills developed in Parametric Modeling and Generative Design (AR1B2). It shifts the sequence's focus from single-author model authoring to the federated, multidisciplinary practice that defines real BIM projects: assembling and coordinating models from multiple disciplines, resolving clashes through a Common Data Environment, collaborating in real time on cloud-based platforms, and tracking design and construction issues through

model-linked BCF and RFI workflows. This course precedes BIM Execution Planning (AR2B2), which formalizes these practices into standards and delivery-method requirements.

3. Goals of the Course

- Coordinate federated, multidisciplinary BIM models to detect and resolve design conflicts before construction, applying a shared Common Data Environment protocol.
- Collaborate on a shared BIM model in real time across disciplines, using cloud-based BIM platforms and agreed model-sharing and worksharing conventions.
- Track and resolve design and construction issues through model-linked workflows, including BCF-based issue tracking, model-based RFIs, and submittal tracking.
- Build hands-on proficiency in the coordination and collaboration software tools covered in the course through guided, cumulative practicum exercises aligned with industry certification.

4. General Competences (*Outcomes*)

AG-A03) Performs effectively as an individual and as a member or leader in diverse, inclusive teams, in multidisciplinary in-person and remote environments. (Usage)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

5. Content

5.1 Multidisciplinary Model Coordination, 24 hr(s)

Competences: AG-A03

Topics: **I:** BIM coordination and clash detection: federated model assembly, hard and soft clash detection in Navisworks or Solibri, clash resolution workflows, and the reduction of RFIs **II:** IFC and open BIM standards: the IFC schema for vendor-neutral model exchange, BCF (BIM Collaboration Format) for issue tracking, and openBIM coordination workflows across authoring platforms **III:** Common Data Environment (CDE): shared, work-in-progress, published, and archive states for model and document management; naming conventions and version control in a multi-party project

Learning Outcomes **I:** Describe the role of model coordination in a multidisciplinary project, including federated models, clash detection, and the Common Data Environment [Familiarity] **II:** Apply BIM coordination tools to detect and resolve clashes in a federated building model, documenting issues through a Common Data Environment workflow [Usage] **III:** Evaluate a model-coordination protocol for a construction project, assessing federation strategy, clash-detection coverage, and CDE governance [Assessment]

Bibliography: [Sacks et al., 2018]

5.2 Collaborative BIM Workflows, 24 hr(s)

Competences: AG-A03

Topics: **I:** BIM collaboration: federated models, clash detection and resolution, model-based quantity takeoff for estimating **II:** Cloud-based BIM collaboration platforms: real-time multi-user editing (BIM 360/ACC, BIMcloud, Trimble Connect), permissions, and worksharing

Learning Outcomes **I:** Describe how cloud-based BIM collaboration platforms support real-time, multi-user, multidisciplinary model development [Familiarity] **II:** Develop a BIM collaboration protocol for a project, specifying model sharing standards, clash detection frequency, and meeting

rhythms [Usage] **III:** Evaluate a project's BIM collaboration setup for its effectiveness in supporting multidisciplinary, real-time teamwork [Assessment]

Bibliography: [Hardin and McCool, 2015]

5.3 Model-Based Issue and RFI Management, 24 hr(s)

Competences: AG-A04

Topics: I: BCF (BIM Collaboration Format)-based issue tracking: creating, assigning, and closing model-linked issues across authoring platforms **II:** Model-based requests for information (RFIs): linking an RFI to specific model elements and views, and tracking its resolution back into the model **III:** Submittal tracking tied to model elements: linking product data and shop-drawing submittals to the BIM elements they specify

Learning Outcomes I: Describe how BCF-based issue tracking, model-based RFIs, and submittal tracking keep design and construction issues linked to specific model elements [Familiarity] **II:** Create, assign, and track a set of model-linked issues through BCF, and link a submittal or RFI to the model elements it affects [Usage] **III:** Evaluate a project's model-based issue log for traceability, timely resolution, and completeness of the links between issues and model elements [Assessment]

Bibliography: [Hardin and McCool, 2015]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: I: Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes I: Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Hardin and McCool, 2015]

6. Bibliography

[Hardin and McCool, 2015] Hardin, B. and McCool, D. (2015). *BIM and Construction Management: Proven Tools, Methods, and Workflows*. Wiley, 2nd edition.

[Sacks et al., 2018] Sacks, R., Eastman, C., Lee, G., and Teicholz, P. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*. Wiley, 3rd edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3R1 3D Modeling and Virtual Animation (Mandatory)

1. General information

- **Semester**: 3rd Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 2 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2R1 Digital Drafting (2nd Sem-Pg. 77)

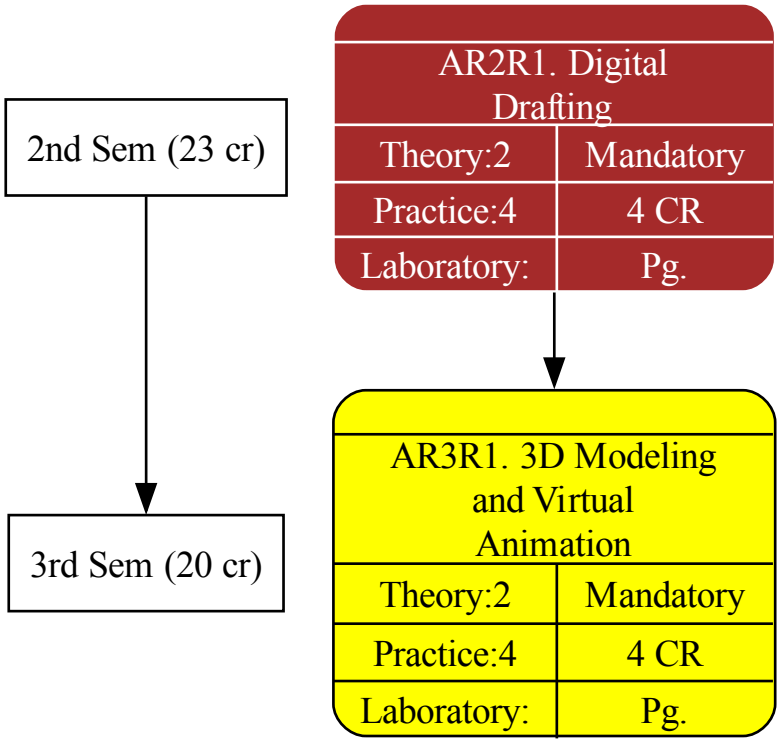


Figure 3.19: Connection Map. AR3R1 3D Modeling and Virtual Animation

2. Course Rationale

3D Modeling and Virtual Animation closes the Representation sequence, building on the CAD/BIM production pipeline from Digital Drafting (ARC2R1) and extending it into real-time 3D, simulation, and immersive media (SketchUp/V-Ray/Blender, Unreal Engine/Twinmotion). It is the course that equips students to actually communicate the territorial and urban proposals developed in the Taller de Urbanismo sequence to authorities, investors, and affected communities – the course's own emphasis on storytelling and citizen participation makes this an explicit communication, not just a visualization, skill.

3. Goals of the Course

- Build geo-referenced, hyperrealistic 3D models of existing or proposed urban environments, integrating multi-sector data (buildings, vegetation, infrastructure).

- Run performance/impact simulations on 3D urban models (daylight, traffic, flood scenarios) to support planning decisions.
- Produce immersive, interactive experiences (VR/AR walkthroughs) with basic navigation and information layers for community engagement.
- Communicate urban proposals persuasively to non-technical audiences through narrative, real-time animation, and storytelling techniques.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Assessment)

5. Content

5.1 Three-Dimensional Modeling, 24 hr(s)

Competences: AG-A06

Topics: I: Geometric modeling types: solid modeling (extrude, loft, revolve, boolean operations), surface modeling (NURBS, patches), mesh modeling (subdivision) **II:** Modeling workflows: massing model (initial concept), schematic model (rooms, openings), detailed model (materials, joinery, fixtures), **III:** 3D rendering for presentation: material assignment (diffuse, roughness, metallic, transparency), lighting setup (directional, point, ambient, HDRI), camera settings (focal length **IV:** UV mapping and texturing: UV coordinates for applying 2D images to 3D surfaces, texture mapping (diffuse, bump, normal, displacement), and avoiding texture stretching and seams **V:** Interoperability between modeling tools: file formats (OBJ, FBX, STEP, STL, 3MF) and common translation issues (lost geometry, material mapping

Learning Outcomes I: Describe the differences between solid, surface, and mesh modeling and identify the appropriate modeling technique for a given architectural task (massing, detailed component [Familiarity] **II:** Create a detailed 3D model of a building component (window, stair, facade panel) using solid modeling operations, then generate a rendered view with materials and lighting [Usage] **III:** Evaluate the quality of a 3D model for a specific use (rendering, 3D printing, BIM integration), assessing geometric accuracy, topology cleanliness, and resolution appropriateness [Assessment]

Bibliography: [Brightman, 2020]

5.2 Simulation and Performance Analysis, 24 hr(s)

Competences: AG-A06

Topics: I: Daylight simulation workflows: importing geometry into Radiance-based tools (DIVA, ClimateStudio), setting materials (reflectance, transmittance), defining sky models (overcast **II:** Energy modeling workflows: setting up geometry in OpenStudio/EnergyPlus or IES VE, defining construction assemblies (U-value, SHGC), schedules, internal loads, HVAC systems, **III:** Solar radiation analysis: calculating incident solar radiation on building surfaces (facade, roof, ground) using Ladybug or ClimateStudio **IV:** Thermal comfort simulation: PMV (predicted mean vote) and adaptive comfort models in EnergyPlus; natural ventilation modeling **V:** Computational fluid dynamics (CFD) for architecture: simplified (zonal) vs. detailed (RANS, LES) airflow simulation

Learning Outcomes I: Describe the main simulation types - daylight, energy, solar radiation, thermal comfort, and airflow - [Familiarity] **II:** Perform a daylight simulation for a building facade using a climate-based model, interpreting sDA and ASE results to adjust aperture size, WWR,

or shading [Usage] **III:** Evaluate a simulation report for a building design, identifying unrealistic inputs (e.g., overly optimistic plug loads, missing shading) [Assessment]

Bibliography: [Akenine-Möller et al., 2018]

5.3 Augmented, Virtual, and Mixed Reality (XR), 24 hr(s)

Competences: AG-A06

Topics: **I:** Virtual reality for architectural design: immersive walkthroughs, scale verification, lighting and material perception, and the use of VR for client presentations **II:** Augmented reality for construction and on-site coordination: overlaying BIM models onto physical construction via tablets or AR glasses (HoloLens) **III:** Mixed reality for collaborative design: multi-user shared virtual environments, real-time sketching and model manipulation across remote locations, **IV:** XR workflow integration: exporting models from Revit, Rhino, or SketchUp to VR platforms (Enscape, Twinmotion, Unreal Engine), optimization for real-time performance (LOD **V:** Usability and ethical considerations in XR for architecture: cybersickness, accessibility for users with disabilities, data privacy in shared virtual spaces,

Learning Outcomes **I:** Describe the differences between virtual reality (VR), augmented reality (AR), and mixed reality (MR), [Familiarity] **II:** Set up a VR walkthrough of an architectural model using a real-time rendering engine, optimizing the model for performance and evaluating the design at 1:1 scale in immersive mode [Usage] **III:** Evaluate the usability of an AR or VR application for a specific architectural task (client presentation, design review, construction QA), identifying technical limitations [Assessment]

Bibliography: [Milovanovic, 2023]

5.4 Architectural Communication and Presentation, 24 hr(s)

Competences: AG-A04

Topics: **I:** Design boards and panels: composition principles (grid, hierarchy, contrast, white space), integrating drawings (plan, section, elevation, axonometric, perspective), renderings **II:** Architectural portfolio design: project selection (range of scales, stages, typologies), portfolio structure, narrative, captioning, **III:** Physical model presentation: material choices (cardboard, foam, acrylic, 3D-printed, laser-cut), scale selection, level of detail, lighting **IV:** Verbal presentation of design: structuring a 5-10 minute design pitch (problem, concept, proposal, testing, conclusion), visual aids, responding to critique, **V:** Architectural diagramming: circulation, program, structure, environmental performance, form generation, process

Learning Outcomes **I:** Describe the key elements of effective architectural communication: narrative structure, visual hierarchy, appropriate level of detail, [Familiarity] **II:** Produce a design presentation board (single panel) for an architectural project that integrates orthographic drawings, rendered views, diagrams, [Usage] **III:** Evaluate a design portfolio or presentation for its communicative effectiveness, identifying strengths in narrative and visual clarity [Assessment]

Bibliography: [Duarte, 2008]

6. Bibliography

[Akenine-Möller et al., 2018] Akenine-Möller, T., Haines, E., and Hoffman, N. (2018). *Real-Time Rendering*. CRC Press, 4th edition.

[Brightman, 2020] Brightman, M. (2020). *The SketchUp Workflow for Architecture*. Wiley, 2nd edition.

[Duarte, 2008] Duarte, N. (2008). *Slide:ology – The Art and Science of Creating Great Presentations*. O'Reilly Media, 1st edition.

[Milovanovic, 2023] Milovanovic, J. (2023). *Unreal Engine for Architectural Visualization*. Packt Publishing, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

ID102 Technical and professional English II (Mandatory)

1. General information

- **Semester**: 3rd Sem. **Credits**: 2
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 2 hours;
- **Prerrequisites**:
  - ID101 Technical and professional English I (2nd Sem-Pg. 80)

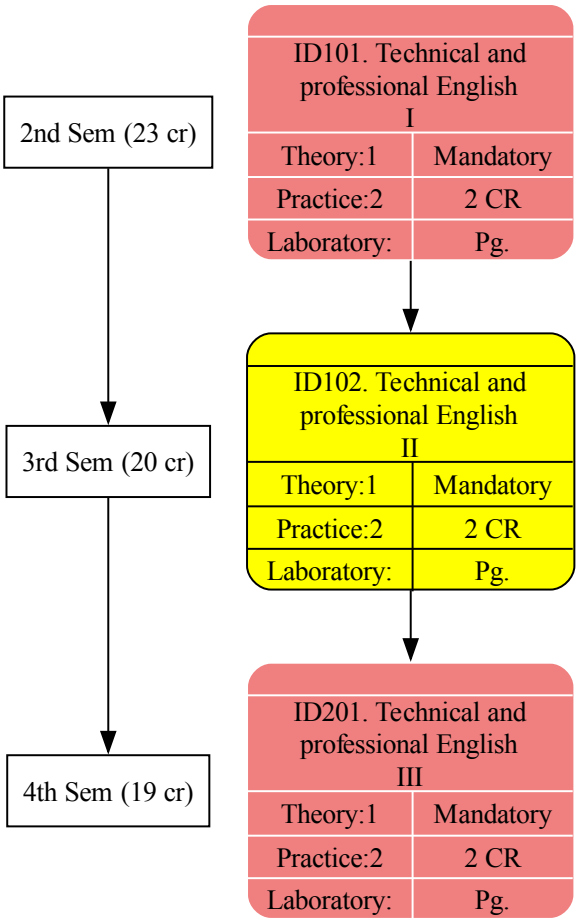


Figure 3.20: Connection Map. ID102 Technical and professional English II

2. Course Rationale

Building on foundational English skills, this course develops the student's ability to communicate in technical and scientific contexts with greater fluency. Grammar structures are practiced through reading and producing descriptions of technological systems, scientific phenomena, and engineering processes. Students gain vocabulary relevant to computing, data, and the physical sciences.

3. Goals of the Course

- Develop fluency in English applied to technical and scientific communication.

- Expand vocabulary in computing, data, and engineering domains.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

5. Content

5.1 Breakthroughs and Discoveries, 12 hr(s)

Competences: AG-A04

Topics: I: Simple Past Review: Affirmative and Negative in scientific contexts. **II:** Time expressions with 'ago': When technologies were invented or released. **III:** Conjunctions: and, so, but, because — structuring technical explanations. **IV:** Vocabulary: Scientific milestones, inventions, and discoveries.

Learning Outcomes I: By the end of the unit, students narrate past technological breakthroughs and connect cause-and-effect relationships using simple past and conjunctions (e.g., "Scientists discovered X, so engineers developed Y").

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.2 Data and Variables, 12 hr(s)

Competences: AG-A04

Topics: I: Countable and Uncountable nouns in computing: files, data, code, memory. **II:** Use of some, any, a lot of in quantifying technical resources. **III:** Expressions of quantity: a little memory, a few errors, too many processes. **IV:** Vocabulary: Data types, variables, constants, and storage units.

Learning Outcomes I: Students correctly use countable and uncountable noun structures to describe data, resources, and system states in technical contexts.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.3 Future of Technology, 12 hr(s)

Competences: AG-A04

Topics: I: Future plans: Verb + to + infinitive in project planning. **II:** Use of 'Will' vs 'Going to' for predictions and scheduled releases. **III:** Auxiliary verbs in forecasting: AI trends, cloud computing, quantum computing. **IV:** Vocabulary: Emerging technologies and career pathways in computing.

Learning Outcomes I: Students express technological intentions and project plans, as well as make evidence-based predictions about computing and engineering trends.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.4 Comparing Technologies, 12 hr(s)

Competences: AG-A04

Topics: I: Comparative and superlative adjectives applied to hardware and software. **II:** Comparing programming languages, operating systems, and algorithms. **III:** Synonyms and antonyms in technical vocabulary. **IV:** Reading: Short technology comparison articles and benchmark reports.

Learning Outcomes **I:** Students make detailed technical comparisons between systems, languages, and tools, using comparative and superlative structures accurately.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.5 Running Processes, 12 hr(s)

Competences: AG-A04

Topics: **I:** Present Continuous to describe active and ongoing technical processes. **II:** Current use: "The server is processing requests." **III:** Future use with Present Continuous: scheduled deployments and experiments. **IV:** Writing: Status updates and progress reports in technical projects.

Learning Outcomes **I:** Students describe active computing processes, ongoing experiments, and scheduled technical activities using the present continuous form.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.6 Software Milestones, 12 hr(s)

Competences: AG-A04

Topics: **I:** Introduction to Present Perfect to describe achievements with current relevance. **II:** Keywords: ever, never, yet, just — applied to software releases and research. **III:** Vocabulary: Version history, patches, upgrades, published papers. **IV:** Reading: Technology news and software changelogs.

Learning Outcomes **I:** Students communicate technical achievements and software milestones with present relevance, without specifying an exact time, using the present perfect.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.7 Technical Challenges, 12 hr(s)

Competences: AG-A04

Topics: **I:** Adjectives ending in -ed and -ing to describe technical experiences and processes. **II:** Modal verbs of obligation: must, have to — applied to engineering requirements. **III:** Vocabulary: Engineering challenges, constraints, trade-offs, and standards. **IV:** Writing: Short technical problem statements.

Learning Outcomes **I:** Students describe the emotional and technical aspects of engineering challenges and express obligations and constraints using specialized vocabulary.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

5.8 English for Technology II, 12 hr(s)

Competences: AG-A04

Topics: **I:** Technical terminology: Input/output devices, storage, and peripherals. **II:** Reading and following software installation and configuration instructions. **III:** Communication in technical support: Describing symptoms and solutions. **IV:** Presentation: Describing a computing system to a non-specialist audience.

Learning Outcomes **I:** By the end of the course, students interpret technical instructions, describe hardware components, and communicate basic computing concepts to diverse audiences in English.

Bibliography: [Soars and John, 2002, Cambridge, 2006, MacGrew, 1999]

6. Bibliography

[Cambridge, 2006] Cambridge (2006). *Diccionario Inglés-Espanol Cambridge*. Editorial Oxford.

[MacGrew, 1999] MacGrew, J. (1999). *Focus on Grammar Basic*. Editorial Oxford.

[Soars and John, 2002] Soars, L. and John (2002). *American Headway N 1 Student Book*. Editorial Oxford.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG364 Ethics (Mandatory)

1. General information

- **Semester**: 3rd Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**:
  - EG264 Philosophy (2nd Sem-Pg. 86)

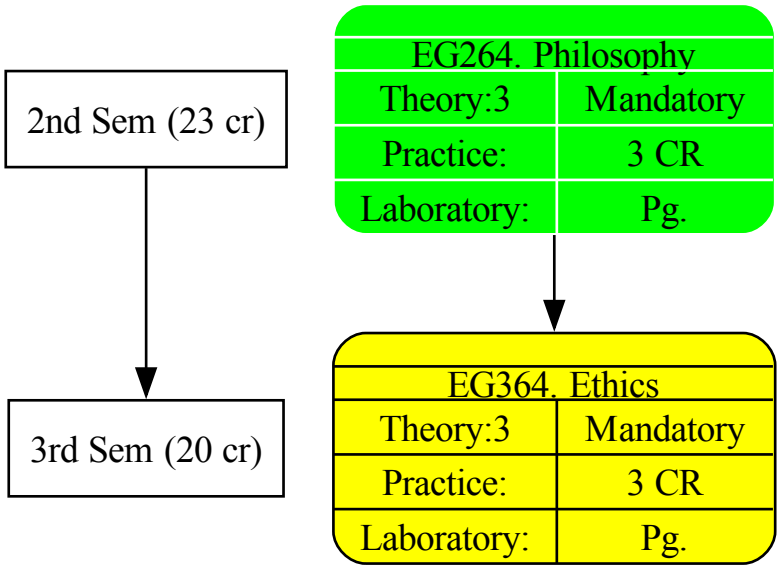


Figure 3.21: Connection Map. EG364 Ethics

2. Course Rationale

Ética pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito capacitar al estudiante en el conocimiento y aplicación de los principios éticos que deben regir su conducta y que le permitan asumir un compromiso ético en su trabajo y en la sociedad. Comprende la ética y la moral, el acto y la persona moral, la conciencia y responsabilidad moral, las teorías éticas y los dilemas morales, el Código de Ética del Colegio de Arquitectos del Perú, los casos de corrupción y falta de ética en la arquitectura, y la ética en proyectos arquitectónicos, licitaciones y ejecución de obras.

3. Goals of the Course

- Reflexionar sobre la importancia de la integridad, la responsabilidad y el compromiso ético en el ejercicio profesional del arquitecto.
- Reflexionar sobre la importancia de la responsabilidad, el cumplimiento normativo y la transparencia en el contexto del Código de Ética del Colegio de Arquitectos del Perú.
- Reflexionar sobre la responsabilidad, el cumplimiento normativo y el rigor profesional frente a dilemas éticos en la práctica arquitectónica.

4. General Competences (*Outcomes*)

AG-A02) Applies ethical principles and the standards of professional architectural practice, respecting the legal framework and human diversity. (Assessment)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Usage)

5. Content

5.1 Fundamentos de la Ética y el Ejercicio Profesional, 15 hr(s)

Competences: AG-A02

Topics: **I:** Presentación de la cátedra, la asignatura y su vínculo con los ODS y la Responsabilidad Social Universitaria. Análisis de conceptos fundamentales. **II:** Contribuciones de la historia a la ética profesional contemporánea. Técnicas de análisis de dilemas éticos. **III:** Ámbitos del ejercicio profesional y conceptos fundamentales de ética. Relación entre ética y responsabilidad social (ODS 8: trabajo decente). **IV:** Casos de corrupción y falta de ética en la arquitectura. Identificación de conductas antiéticas y repercusiones en proyectos arquitectónicos. Protocolos de actuación ante situaciones antiéticas.

Learning Outcomes **I:** Analiza el contenido y la metodología del curso, y su vínculo con los ODS y la Responsabilidad Social Universitaria. [Familiarity]. **II:** Analiza las contribuciones de la historia a la ética profesional contemporánea y las técnicas de análisis de dilemas éticos, resolviendo un ejercicio práctico sobre el impacto del desarrollo urbano. [Usage]. **III:** Contrasta los ámbitos del ejercicio profesional y los eventuales dilemas éticos que podrían generarse, relacionando la ética con la responsabilidad social y el ODS 8 (trabajo decente). [Usage]. **IV:** Analiza casos de corrupción y falta de ética en la arquitectura, identificando conductas antiéticas y sus repercusiones en proyectos arquitectónicos. [Usage].

Bibliography: [López, 2019, Santos and Pérez, 2017]

5.2 El Código de Ética del CAP y el Contexto de la Construcción, 21 hr(s)

Competences: AG-A02

Topics: **I:** Revisión del Código de Ética del CAP: estructura, fundamentos y antecedentes. Principios y lineamientos específicos. **II:** Responsabilidad del arquitecto según el CAP: responsabilidad civil, penal y ética. Dilema sobre el trámite, ejecución e inspección municipal. **III:** Dilemas éticos y el entorno sociocultural en la práctica arquitectónica en el contexto peruano. Normas de transparencia y anticorrupción. **IV:** Casos de corrupción y falta de ética en la arquitectura: identificación de conductas antiéticas y repercusiones en la ejecución de obras. Protocolos de actuación.

Learning Outcomes **I:** Analiza métodos para identificar lineamientos éticos en documentos normativos, revisando la estructura, fundamentos y antecedentes del Código de Ética del Colegio de Arquitectos del Perú (CAP). [Usage]. **II:** Analiza la responsabilidad civil, penal y ética del arquitecto según el CAP, resolviendo un dilema sobre el trámite, ejecución e inspección municipal. [Usage]. **III:** Organiza el proceso educativo integrando contenidos que fomenten la reflexión ética y el pensamiento crítico frente a dilemas éticos y el entorno sociocultural en la práctica arquitectónica peruana. [Usage]. **IV:** Organiza mediación en conflictos éticos a partir de casos de corrupción y falta de ética en la arquitectura, identificando conductas antiéticas y repercusiones en la ejecución de obras. [Usage].

Bibliography: [Colegio de Arquitectos del Perú, , Martínez, 2016]

5.3 Ética y Dilemas Éticos en la Práctica Arquitectónica, 18 hr(s)

Competences: AG-A05

Topics: **I:** Ética social y ambiental de la arquitectura. Riesgos y seguridad sociales y ambientales en la responsabilidad profesional e institucional. **II:** Ética en proyectos arquitectónicos y sus autorizaciones municipales. Riesgos y dilemas éticos. Evaluación crítica de un proyecto de habilitación urbana. **III:** Ética en licitaciones y ejecuciones de obras. Riesgos y dilemas éticos. Evaluación crítica de un proceso de licitación y ejecución de obras.

Learning Outcomes **I:** Analiza la ética social y ambiental de la arquitectura, y organiza mediación en conflictos éticos relacionados con riesgos y seguridad ambiental en la responsabilidad profesional e institucional. [Usage]. **II:** Analiza los riesgos y dilemas éticos en proyectos arquitectónicos y sus autorizaciones municipales, desarrollando una evaluación crítica de un proyecto de habilitación urbana. [Assessment]. **III:** Analiza los riesgos y dilemas éticos en licitaciones y ejecuciones de obras, desarrollando una evaluación crítica de un proceso de licitación y ejecución de obras. [Assessment].

Bibliography: [Pérez and Castillo, 2017, García, 2018]

6. Bibliography

[Colegio de Arquitectos del Perú,] Colegio de Arquitectos del Perú. Código de Ética del colegio de arquitectos del perú.
urlhttp://www.colegioarquitectos.gob.pe/codigo-etica.

[García, 2018] García, M. (2018). Ética y responsabilidad ambiental en la arquitectura. Green Building Journal.

[López, 2019] López, R. (2019). La responsabilidad social del arquitecto.

[Martínez, 2016] Martínez, J. (2016). Dilemas Éticos en la construcción.

[Pérez and Castillo, 2017] Pérez, A. and Castillo, D. (2017). La Ética en el urbanismo: Un enfoque desde el derecho y la arquitectura.

[Santos and Pérez, 2017] Santos, M. and Pérez, L. (2017). Ética, arquitectura y sostenibilidad: Desafíos contemporáneos. Revista de Arquitectura.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG366 Personal Development and Leadership (Mandatory)

1. General information

- **Semester**: 3rd Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

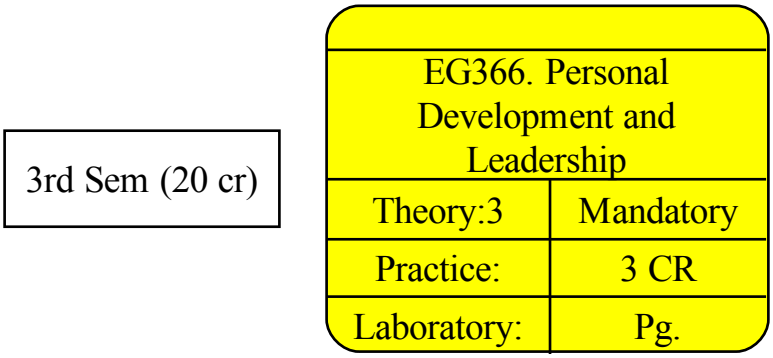


Figure 3.22: Connection Map. EG366 Personal Development and Leadership

2. Course Rationale

Desarrollo Personal y Liderazgo pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito desarrollar habilidades personales y sociales de los estudiantes, potenciando el avance de actitudes de comunicación asertiva, liderazgo y sana convivencia e inclusión con personas con discapacidad, favoreciendo su crecimiento personal y profesional. Comprende la inteligencia emocional, la inteligencia intrapersonal e interpersonal, el proyecto de vida, el liderazgo, la discapacidad, la persona con discapacidad, los tipos de discapacidad y los derechos de la persona con discapacidad.

3. Goals of the Course

- Reconocer la inteligencia emocional y poner en práctica herramientas como el autoconocimiento y la automotivación.
- Reconocer la importancia del desarrollo personal y aplicarla en su entorno para una convivencia armoniosa.
- Identificar los tipos de discapacidad y analizar críticamente el desenvolvimiento en la sociedad, utilizando diversas estrategias de inclusión.

4. General Competences (*Outcomes*)

AG-A03) Performs effectively as an individual and as a member or leader in diverse, inclusive teams, in multidisciplinary in-person and remote environments. (Usage)

5. Content

5.1 Inteligencia Emocional, 15 hr(s)

Competences: AG-A03

Topics: **I:** Introducción al curso. Dinámica de conocimiento e integración. **II:** Inteligencia emocional: reconociendo mis emociones. **III:** Conocimiento e integración. **IV:** Auto conciencia: autoconocimiento. **V:** Automotivación.

Learning Outcomes **I:** Expresa sus expectativas, comparte sus inquietudes y reconoce su rol como estudiante. [Familiarity]. **II:** Expresa y dramatiza el reconocimiento de sus propias emociones. [Familiarity]. **III:** Realiza actividades grupales de participación usando habilidades verbales, no verbales y flexibilidad cognitiva. [Usage]. **IV:** Mediante un instrumento estandarizado y técnicas no verbales, reconoce las características personales que potencian y pueden dificultar su adaptación a la educación superior. [Usage]. **V:** Utiliza estrategias de automotivación y motivación a otros, poniéndolas en práctica. [Usage].

Bibliography: [Goleman, 1997, Encinas, 1997]

5.2 Desarrollo Personal, 21 hr(s)

Competences: AG-A03

Topics: **I:** Autorregulación. Flexibilidad cognitiva: mi FODA personal. Diseño de un plan personal. **II:** Regulación de emociones. **III:** Autoestima y asertividad. **IV:** Escucha activa. **V:** Conceptualización de la discapacidad y persona con discapacidad, y tipos de discapacidad.

Learning Outcomes **I:** Expresa a través de un instrumento las actitudes positivas y las debilidades a mejorar, utilizando técnicas de aprender a pensar (FODA personal y diseño de un plan personal). [Usage]. **II:** Analiza casos y realiza autoanálisis de sus emociones en la regulación de las mismas. [Usage]. **III:** Utiliza frases asertivas para expresar puntos de conflicto considerando la inclusividad, en el desarrollo de la autoestima y la asertividad. [Usage]. **IV:** Mejora las habilidades de escucha activa de manera inclusiva. [Usage]. **V:** Socializa la Ley General de las Personas con Discapacidad, entendiendo y asumiendo un rol de respeto y tolerancia hacia las personas con discapacidad. [Usage].

Bibliography: [Basili, 1996, Riso, 1997]

5.3 Habilidades Sociales e Inclusión, 18 hr(s)

Competences: AG-A03

Topics: **I:** Derechos de una persona con discapacidad. Empatía: educación inclusiva para niños y niñas con necesidades educativas especiales asociadas a discapacidad. **II:** Tolerancia y apertura a la discapacidad. Estereotipos que debemos superar sobre personas con discapacidad. **III:** Trabajo en equipo y liderazgo: preparación de un proyecto de Proyección Social y de Servicio Universitario (PSSU) en una institución vulnerable. **IV:** Discapacidad e inclusión social. Ejecución del Plan de Actividad de PSSU en una institución de personas con habilidades diferentes.

Learning Outcomes **I:** Identifica las principales características de las personas con necesidades especiales asociadas a la discapacidad, en el marco de los derechos de una persona con discapacidad. [Usage]. **II:** Realiza un producto sobre la inclusión de personas con discapacidad, abordando tolerancia, apertura y estereotipos a superar. [Usage]. **III:** Prepara y aplica un proyecto de Proyección Social y de Servicio Universitario (PSSU) en una institución vulnerable con personas con discapacidad, trabajando en equipo y liderazgo. [Usage]. **IV:** Ejecuta el plan de actividad de PSSU en una institución de personas con habilidades diferentes, y realiza un informe sobre las actividades realizadas. [Usage].

Bibliography: [Ley, , Encinas, 2001]

6. Bibliography

[Ley,] Ley general de la persona con discapacidad y su reglamento. Gob.pe.

[Basili, 1996] Basili, F. (1996). *La Construcción de la Identidad*. Asociación Germinal.

[Encinas, 1997] Encinas, S. (1997). Conociéndonos: Reflexiones sobre autoestima.

[Encinas, 2001] Encinas, S. (2001). ¡muévete!: Desarrollo de habilidades y actitudes de liderazgo juvenil.

[Goleman, 1997] Goleman, D. (1997). *Inteligencia Emocional*. Kairós.

[Riso, 1997] Riso, W. (1997). *Sabiduría Emocional*. Editorial Norma.

Fourth Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR1T1 Digital Topography (Mandatory)

1. General information

- **Semester**: 4th Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 4 hours;
- **Prerrequisites**: None

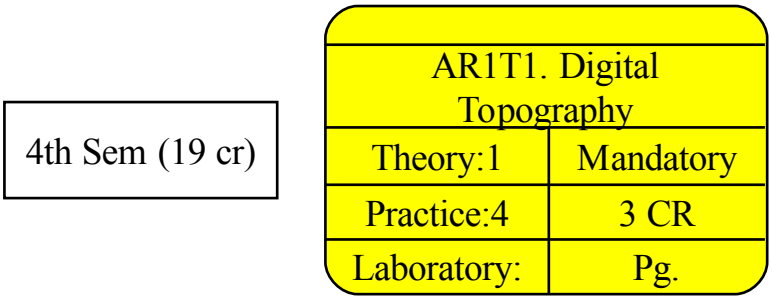


Figure 3.23: Connection Map. AR1T1 Digital Topography

2. Course Rationale

Digital Topography gives students the territorial-measurement and geospatial-data foundation – scale, coordinate systems, cartography, GIS, remote sensing – that every subsequent territorial-analysis and urban-planning studio course assumes. Unlike a classic surveying course centered on field instruments, this one is built on Territorial Analysis and Urban Information Systems (TAN), the Urbanism BOK's own knowledge area for exactly this content, so its digital/GIS emphasis matches how terrain and cadastral data are actually produced and consumed in contemporary urban planning practice.

3. Goals of the Course

- Apply core territorial concepts (scale, spatial reference systems, coordinate systems) to locate and describe any urban or territorial element precisely.
- Produce coordinated cartographic representations of terrain, cadastral boundaries, and infrastructure at multiple scales.
- Build and query GIS datasets (vector/raster layers, attribute tables) to support urban and territorial analysis.
- Interpret remote-sensing and LIDAR-derived data (digital terrain models, slope/drainage analysis) for site diagnostics.

4. General Competences (*Outcomes*)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Assessment)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Assessment)

5. Content

5.1 Territorial Concepts, Scales, and Spatial Reference, 20 hr(s)

Competences: AG-A07

Topics: **I:** Territory, place, region, landscape, and spatial extent as concepts for urban and territorial analysis **II:** Parcel, block, neighborhood, municipality, metropolitan area, and region; scale effects and the modifiable areal unit problem **III:** Census tracts, municipal limits, watersheds, labor-market areas, and metropolitan functional regions **IV:** Geographic coordinates, projected coordinate reference systems, datums, map projections, and units **V:** Adjacency, containment, distance, direction, topology, and their role in geographic analysis **VI:** Scale, resolution, extent, positional accuracy, and temporal resolution and their effects on interpretation

Learning Outcomes **I:** Describe territorial units, analytical scales, boundaries, and coordinate systems used in urban analysis [Familiarity] **II:** Select defensible spatial units and coordinate systems for an urban or territorial research question [Usage] **III:** Evaluate how scale, boundary choice, resolution, and spatial reference affect an urban analysis [Assessment]

Bibliography: [Ghilani and Wolf, 2020]

5.2 Cartography and Spatial Representation, 20 hr(s)

Competences: AG-A07

Topics: **I:** Map purpose, audience, extent, scale, projection, legend, title, sources, and orientation **II:** Visual variables for spatial data: location, size, shape, hue, value, texture, and orientation **III:** Quantitative map classification: equal interval, quantile, natural breaks, and implications for interpretation **IV:** Choropleth, proportional symbol, dot density, flow, isarithmic, and bivariate maps and their suitable data types **V:** Communication of positional, attribute, temporal, and model uncertainty without misleading emphasis **VI:** Legibility, color-vision accessibility, visual hierarchy, annotation, and public-facing map design

Learning Outcomes **I:** Identify cartographic choices that shape how urban data are represented and interpreted [Familiarity] **II:** Produce a thematic map with an appropriate projection, classification, visual hierarchy, and source documentation [Usage] **III:** Evaluate a map for accuracy, legibility, accessibility, and risk of misrepresenting spatial patterns [Assessment]

Bibliography: [Ghilani and Wolf, 2020]

5.3 Geographic Information Systems, 20 hr(s)

Competences: AG-A06

Topics: **I:** Vector points, lines, polygons, raster grids, attributes, geometry, and topology **II:** Spatial databases, schemas, metadata, identifiers, coordinate systems, and geospatial layer management **III:** Attribute and spatial queries: selection, overlay, proximity, spatial join, and Boolean combinations **IV:** Buffer, clip, dissolve, intersect, union, network analysis, raster reclassification, and zonal statistics **V:** Integration of census, parcel, land-use, transport, environment, and field-survey layers with differing scales and schemas **VI:** Documented processing models, open formats, versioned inputs, quality checks, and reproducible outputs

Learning Outcomes **I:** Explain GIS data models and spatial queries used in urban analysis [Familiarity] **II:** Implement a documented GIS workflow that integrates urban datasets and produces a planning-relevant output [Usage] **III:** Validate a GIS analysis for coordinate alignment, topology, attribute integrity, and reproducibility [Assessment]

Bibliography: [Longley et al., 2015]

5.4 Remote Sensing and Earth Observation, 20 hr(s)

Competences: AG-A06

Topics: **I:** Satellite, aerial, and UAV platforms and their spatial, spectral, temporal, and radiometric resolution **II:** Spectral signatures, bands, color composites, texture, and contextual interpretation of urban features **III:** Supervised, unsupervised, and object-based land-cover classification; training data and accuracy assessment **IV:** Urban expansion, densification, land-cover change, and temporal comparison of imagery **V:** Spectral indicators of vegetation, impervious surface, water, and surface temperature **VI:** Cloud, shadow, mixed pixels, sensor differences, classification error, and limits of inferring social conditions from imagery

Learning Outcomes **I:** Describe remote-sensing data types and their uses and limitations for observing cities [Familiarity] **II:** Classify an urban land-cover image and document training data, processing choices, and accuracy [Usage] **III:** Evaluate a remote-sensing result for resolution, accuracy, comparability, and planning fitness [Assessment]

Bibliography: [Campbell and Wynne, 2021]

6. Bibliography

[Campbell and Wynne, 2021] Campbell, J. B. and Wynne, R. H. (2021). *Introduction to Remote Sensing*. The Guilford Press, 6th edition.

[Ghilani and Wolf, 2020] Ghilani, C. D. and Wolf, P. R. (2020). *Elementary Surveying: An Introduction to Geomatics*. Pearson, 15th edition.

[Longley et al., 2015] Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W. (2015). *Geographic Information Science and Systems*. Wiley, 4th edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2B2 BIM Execution Planning (Mandatory)

1. General information

- **Semester**: 4th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2B1 Multidisciplinary Coordination (3rd Sem-Pg. 96)

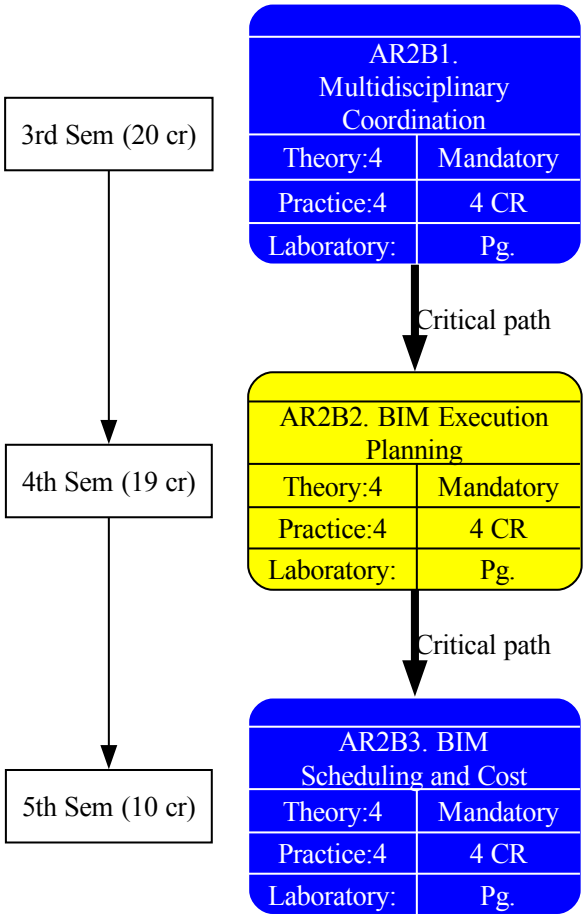


Figure 3.24: Connection Map. AR2B2 BIM Execution Planning

2. Course Rationale

BIM Execution Planning is the fourth course of the ten-course BIM I-X sequence (AR1B1 to AR4B1), following Multidisciplinary Coordination (AR2B1, prerequisite). Having learned to author, document, organize, coordinate, and collaborate on a shared BIM model in the first three courses, students now step back to the project-management layer that governs how BIM itself is planned, mandated, and contracted: drafting a BIM Execution Plan (BEP) and information-delivery requirements under ISO 19650, identifying the national and jurisdictional BIM mandates and contractual provisions (model authorship, liability, intellectual property) that apply to a given project, and matching

a project's delivery method – Design-Bid-Build, Design-Build, Construction Management at Risk, or Integrated Project Delivery – to the BIM maturity level it actually requires. The course's transversal Practicum unit continues the hands-on software-lab component that recurs, unchanged in structure, across all ten courses of the sequence.

3. Goals of the Course

- Draft a BIM Execution Plan (BEP) for a project, specifying BIM goals, LOD matrix, and information-delivery milestones aligned with the ISO 19650 framework.
- Identify the BIM mandate or policy applicable to a given project's jurisdiction, and draft contractual provisions addressing model authorship, liability, and intellectual property for shared model data.
- Recommend a project delivery method (Design-Bid-Build, Design-Build, Construction Management at Risk, or IPD) and a target BIM maturity level appropriate to a given project's scale and ownership structure.
- Build hands-on proficiency in a BIM authoring/collaboration tool through a sequence of guided, graded practicum exercises culminating in a cumulative deliverable.

4. General Competences (*Outcomes*)

AG-A02) Applies ethical principles and the standards of professional architectural practice, respecting the legal framework and human diversity. (Usage)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Usage)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

5. Content

5.1 BIM Execution Planning and Standards, 24 hr(s)

Competences: AG-A05

Topics: **I:** BIM Execution Plan (BEP): project goals for BIM use (clash detection, 4D/5D, facility management), LOD matrix by discipline, model sharing protocols **II:** ISO 19650 framework: information management using BIM across the delivery and operational phases of assets, information requirements (EIR, OIR, AIR), and the information-delivery cycle

Learning Outcomes **I:** Describe the purpose of a BIM Execution Plan and the ISO 19650 information-management framework, and explain how they structure a project's BIM deliverables [Familiarity] **II:** Draft a BIM Execution Plan for a project, specifying BIM goals, LOD matrix, and information-delivery milestones aligned with ISO 19650 [Usage] **III:** Evaluate a BIM Execution Plan for a design project, assessing its LOD specifications, exchange protocols, and BIM use cases for adequacy and clarity [Assessment]

Bibliography: [Computer Integrated Construction Research Program, 2011]

5.2 BIM Standards, Policy, and Contracts, 24 hr(s)

Competences: AG-A02

Topics: **I:** National and regional BIM adoption mandates: policy frameworks requiring BIM on public infrastructure projects (e.g. Peru's Plan BIM Perú, UK BIM Mandate, EU BIM Task Group), and their implications for permit submission and interdisciplinary coordination **II:** BIM in contracts and risk allocation: BIM Execution Plans as contract exhibits, model-authorship and liability clauses, and intellectual-property considerations for shared model data

Learning Outcomes I: Describe the major national and international BIM policy frameworks, and explain how BIM Execution Plans and authorship clauses are used to allocate contractual risk [Familiarity] **II:** Identify the BIM mandate or policy applicable to a given project's jurisdiction, and draft a contract clause addressing model authorship and liability [Usage] **III:** Evaluate a project's compliance with applicable BIM mandates and the adequacy of its contractual provisions for model authorship and liability [Assessment]

Bibliography: [Kensek and Noble, 2014]

5.3 BIM Across Project Delivery Methods, 24 hr(s)

Competences: AG-A05

Topics: I: Project delivery methods and their effect on BIM responsibility: Design-Bid-Build, Design-Build, Construction Management at Risk, and Integrated Project Delivery (IPD) **II:** BIM maturity levels (Level 0-3): from unmanaged CAD to fully collaborative, cloud-based, integrated BIM, and how procurement choice shapes the achievable level **III:** Risk- and reward-sharing models in IPD and alliance contracts, and their relationship to shared BIM model responsibility

Learning Outcomes I: Describe how different project delivery methods assign BIM responsibility differently, and explain the BIM maturity level framework [Familiarity] **II:** Recommend a project delivery method and target BIM maturity level appropriate for a given project's scale and ownership structure [Usage] **III:** Evaluate a project's chosen delivery method for whether it supports the BIM maturity level the project actually requires [Assessment]

Bibliography: [Fischer et al., 2017]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: I: Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes I: Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Stine, 2023]

6. Bibliography

[Computer Integrated Construction Research Program, 2011] Computer Integrated Construction Research Program (2011). Bim project execution planning guide. Version 2.1, Pennsylvania State University.

[Fischer et al., 2017] Fischer, M., Ashcraft, H. W., Reed, D., and Khanzode, A. (2017). *Integrating Project Delivery*. Wiley, 1st edition.

[Kensek and Noble, 2014] Kensek, K. M. and Noble, D. E., editors (2014). *Building Information Modeling: BIM in Current and Future Practice*. Wiley, 1st edition.

[Stine, 2023] Stine, D. J. (2023). *Autodesk Revit 2024 for Architecture*. SDC Publications, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2D1 Design Studio IV (Mandatory)

1. General information

- **Semester**: 4th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR1D3 Design Studio III (3rd Sem-Pg. 92)

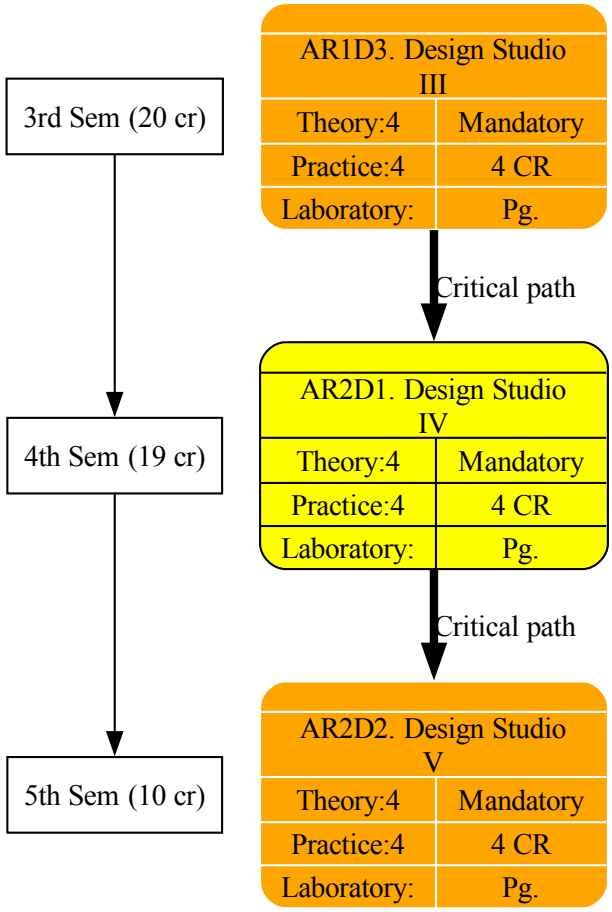


Figure 3.25: Connection Map. AR2D1 Design Studio IV

2. Course Rationale

Design Studio IV: Neighborhood Facilities is the student's first public-building project, following Design Studio III (AR1D3, prerequisite). Working at the scale of a neighborhood library or a community health post, students design a medium-scale public facility and, for the first time in the sequence, develop its structural system explicitly as part of the architectural proposal – selecting and sizing the vertical and lateral load-resisting elements, and coordinating them with construction assemblies, natural ventilation strategies, and the applicable building codes. This course is the foundation for Design Studio V (AR2D2).

3. Goals of the Course

- Apply the fundamental principles of structural mechanics (loads, equilibrium, internal forces) to the design of a medium-scale public building.
- Select and size the vertical and lateral load-resisting systems (columns, walls, frames, diaphragms) of a neighborhood facility.
- Coordinate structural, envelope, and interior systems into a constructible building assembly.
- Verify a design proposal's compliance with applicable building codes, accessibility standards, and zoning regulations.
- Design naturally ventilated spaces using cross-ventilation and stack-effect strategies appropriate to the building's program and climate.

4. General Competences (*Outcomes*)

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)

AG-A12) Possesses the design skills needed to satisfy building users' requirements within cost constraints and building regulations. (Usage)

AG-A14) Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture. (Usage)

5. Content

5.1 Structural Principles and Mechanics, 10 hr(s)

Competences: AG-A08

Topics: **I:** Types of loads: dead, live, snow, wind, seismic, and thermal; load combinations per ASCE 7; internal force diagrams (axial, shear, moment) in statically determinate beams **II:** Stress-strain relationships for common structural materials: elastic and plastic behavior, yield strength, ultimate strength, modulus of elasticity, and ductility **III:** Static equilibrium equations ($\sum F_x = 0$, $\sum F_y = 0$, $\sum M = 0$) and calculation of support reactions in beams, trusses, and simple frames **IV:** Truss analysis: method of joints, method of sections, zero-force members, and truss configurations (howe, pratt, warren, vierendeel) for different span conditions **V:** Beam deflection: moment-area method, superposition, and the role of deflection limits (L/360, L/240) in serviceability design

Learning Outcomes **I:** Describe the primary types of structural loads and internal forces, and explain how they influence the sizing and configuration of structural elements [Familiarity] **II:** Calculate support reactions, shear and moment diagrams, and deflection in simple statically determinate beams and trusses [Usage] **III:** Evaluate the structural adequacy of a simple beam or truss configuration against given load and deflection criteria, proposing cross-section or material changes where needed [Assessment]

Bibliography: [Schierle, 2012, Onouye and Kane, 2017]

5.2 Vertical Load Path and Foundations, 10 hr(s)

Competences: AG-A08

Topics: **I:** Vertical load-bearing systems: short vs. slender columns, buckling (Euler), effective length factor; load-bearing walls (masonry, concrete, timber, steel studs) **II:** Foundation systems and load transfer: spread footings, continuous footings, pile caps, grade beams, and the role of connections in ensuring load path continuity **III:** Structural grid design: bay sizes, column spacing implications for floor framing (one-way vs. two-way slabs, beam-and-girder, flat plate, flat slab),

Learning Outcomes **I:** Identify the primary vertical load-bearing elements and foundation systems in a building, and describe how loads are transferred from the structural grid to the foundation [Familiarity] **II:** Select and configure an appropriate column/wall system, foundation type, and structural grid for a medium-rise building, considering program and material availability [Usage] **III:** Evaluate a building's vertical load path for continuity and foundation adequacy, identifying potential load-transfer discontinuities [Assessment]

Bibliography: [Schierle, 2012, Onouye and Kane, 2017]

5.3 Natural Ventilation and Indoor Air Quality, 8 hr(s)

Competences: AG-A08

Topics: **I:** Drivers for natural ventilation: wind pressure coefficients (C_p), stack effect (buoyancy), and combined wind and stack; ventilation rate calculation using the orifice equation **II:** Cross-ventilation and stack ventilation design: opening placement (inlet vs. outlet heights), room depth limits for effective cross-flow (2-2.5× floor-to-ceiling height) **III:** Indoor air quality standards and contaminants: ASHRAE 62.1 ventilation rate procedure, indoor pollutant sources (VOCs, CO_2, particulates), **IV:** Mixed-mode (hybrid) ventilation: sequencing strategies (changeover, zoned, concurrent), control logic for switching between natural and mechanical modes, **V:** Airflow simulation for natural ventilation: computational fluid dynamics (CFD) for detailed analysis, zonal models for early design, and wind tunnel testing for complex geometries

Learning Outcomes **I:** Describe the physical drivers of natural ventilation - wind and stack effect - and explain how opening size, placement, and building depth influence airflow rates [Familiarity] **II:** Design a natural ventilation strategy for a building in a moderate climate, specifying opening sizes, heights, [Usage] **III:** Evaluate a naturally ventilated building design using airflow simulation or simplified calculations, identifying zones with insufficient ventilation [Assessment]

Bibliography: [Brown and DeKay, 2001]

5.4 Building Systems and Assemblies, 12 hr(s)

Competences: AG-A14

Topics: **I:** Integration of building systems: coordinating structural frame, mechanical/electrical/plumbing (MEP), envelope, and interior fit-out within constrained floor-to-floor heights **II:** Construction documentation for assemblies: details at 1:5, 1:10, and 1:20; section-through-wall details, sill and head conditions, and coordination between architectural **III:** Construction tolerances and coordination: dimensional tolerances in concrete, steel, and masonry; clearances for MEP rough-in **IV:** Waterproofing and moisture management: below-grade waterproofing systems, drainage planes, vapor barriers, and flashing at penetrations **V:** Fire-rated assemblies: UL-listed wall, floor, and ceiling assemblies; fire-stopping at penetrations, intumescent seals, and the architectural detailing required by fire codes **VI:** Prefabricated and modular assemblies: volumetric modular construction, panelized wall systems, and the design implications of off-site manufacturing tolerances

Learning Outcomes **I:** Identify the principal building systems and describe how they are integrated and coordinated within a multi-story building assembly [Familiarity] **II:** Develop construction-level details for a building assembly that correctly coordinate structural, envelope, and MEP systems within realistic tolerances and code requirements [Usage] **III:** Evaluate a set of construction documents for assembly coordination quality, identifying conflicts, missing details, and buildability risks [Assessment]

Bibliography: [Allen and Iano, 2019]

5.5 Building Codes, Accessibility, and Zoning, 10 hr(s)

Competences: AG-A12

Topics: **I:** Building codes and standards: IBC (International Building Code), IRC (International Residential Code), IFC (International Fire Code) **II:** Means-of-egress and fire-evacuation route design: maximum travel distance to an exit, number and width of exits required by occupant load, exit discharge and assembly points, and diagramming evacuation routes on a life-safety plan **III:** Accessibility codes: ADA Standards for Accessible Design, ICC A117.1, and local accessible building codes **IV:** Energy codes: IECC (International Energy Conservation Code), ASHRAE 90.1; prescriptive vs. performance paths **V:** Zoning and land use regulations: zoning districts (residential, commercial, industrial, mixed-use), floor area ratio (FAR), lot coverage, setbacks, height limits **VI:** Permitting process: building permit, variance, special exception; code interpretation appeals; the architect's role in preparing permit sets, responding to plan review comments

Learning Outcomes **I:** Describe the key provisions of building codes that affect architectural design - occupancy classification, means of egress, fire-resistance, accessibility, and energy performance [Familiarity] **II:** Apply IBC occupancy and construction type tables to determine allowable building area and height for a given use and sprinkler status, [Usage] **III:** Evaluate a building design's code compliance for accessibility (ADA) and life safety (IBC), identifying violations and recommending code-conforming modifications [Assessment]

Bibliography: [Ching and Winkel, 2017]

6. Bibliography

[Allen and Iano, 2019] Allen, E. and Iano, J. (2019). *Fundamentals of Building Construction: Materials and Methods*. Wiley, 7th edition.

[Brown and DeKay, 2001] Brown, G. Z. and DeKay, M. (2001). *Sun, Wind, and Light: Architectural Design Strategies*. Wiley, 2nd edition.

[Ching and Winkel, 2017] Ching, F. D. K. and Winkel, S. R. (2017). *Building Codes Illustrated: A Guide to Understanding the International Building Code*. Wiley, 6th edition.

[Onouye and Kane, 2017] Onouye, B. and Kane, K. (2017). *Statics and Strength of Materials for Architecture and Building Construction*. Pearson, 5th edition.

[Schierle, 2012] Schierle, G. G. (2012). *Architectural Structures*. University of Southern California.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

ID201 Technical and professional English III (Mandatory)

1. General information

- **Semester**: 4th Sem. **Credits**: 2
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 2 hours;
- **Prerrequisites**:
  - ID102 Technical and professional English II (3rd Sem-Pg. 103)

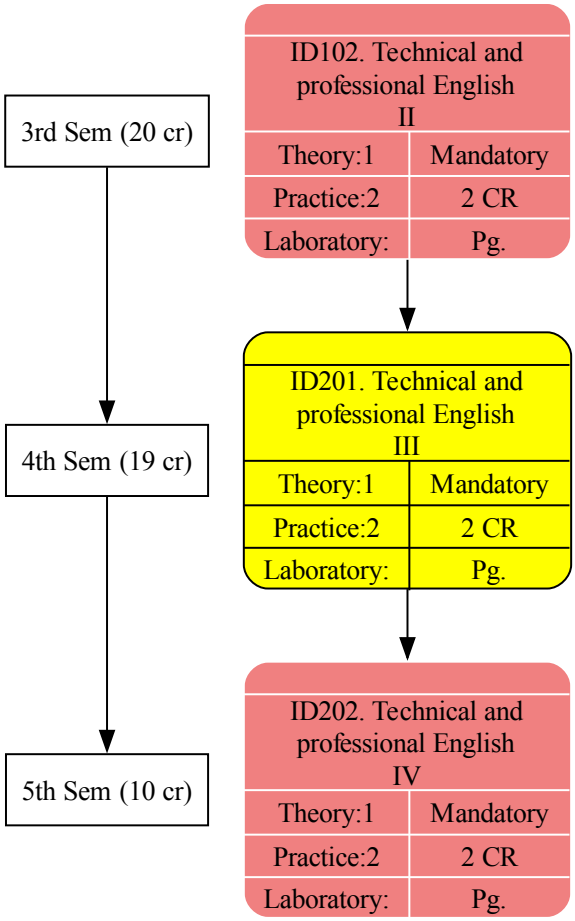


Figure 3.26: Connection Map. ID201 Technical and professional English III

2. Course Rationale

At this level, students engage with English as the primary medium for accessing and producing technical content in computing, engineering, and the sciences. Grammar structures are applied to reading scientific articles, writing technical reports, describing engineering processes, and participating in professional discussions. The course bridges everyday English fluency with the demands of technical communication.

3. Goals of the Course

- Train students to read, understand, and produce technical communication in English.
- Provide linguistic tools for connecting ideas in descriptive and analytical writing about computing and engineering.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

5. Content

5.1 Technical Communication, 12 hr(s)

Competences: AG-A04

Topics: **I:** Review of Tenses: Present, Past, and Future in technical documentation. **II:** Interrogative sentences with complex Wh- questions for system analysis. **III:** Words with more than one meaning in technical contexts (Polysemy). **IV:** Expressions for describing professional activities and research interests.

Learning Outcomes **I:** By the end of the unit, students use various tenses to exchange detailed technical information and formulate precise questions about computing systems and engineering processes.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.2 Comparing Architectures, 12 hr(s)

Competences: AG-A04

Topics: **I:** Use of "What's it like?": Describing system characteristics and interfaces. **II:** Advanced comparative and superlative adjectives in benchmark analysis. **III:** Collocations in computing: high-performance, low-level, fault-tolerant. **IV:** Reading: Architecture comparison reports (RISC vs. CISC, SQL vs. NoSQL).

Learning Outcomes **I:** Students analyze and describe differences between computing architectures, frameworks, and systems using varied comparative structures with technical precision.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.3 Then and Now in Computing, 12 hr(s)

Competences: AG-A04

Topics: **I:** Present Perfect vs. Simple Past: Contrasting historic events with current state. **II:** Time expressions: for, since, ever, never applied to technology evolution. **III:** Adverbs of time and manner in scientific narrative. **IV:** Vocabulary: Generations of technology, legacy systems, current platforms.

Learning Outcomes **I:** Students differentiate and correctly apply the present perfect and the simple past to narrate the evolution of computing technologies and contrast historical achievements with the current state of the field.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.4 Engineering Standards and Protocols, 12 hr(s)

Competences: AG-A04

Topics: **I:** Modals of obligation and permission: Have to, Must, Can in professional norms. **II:** Giving technical recommendations: Should, Ought to — code reviews and design. **III:** Vocabulary: IEEE/ACM standards, coding conventions, security policies. **IV:** Formal writing: Technical memos and engineering recommendations.

Learning Outcomes I: Students express engineering rules, standards, and professional recommendations using appropriate modal verbs in formal technical writing and peer discussion.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.5 How Systems Are Built, 12 hr(s)

Competences: AG-A04

Topics: **I:** Passive Voice: Present and Simple Past to describe engineering processes. **II:** Vocabulary: Manufacturing, deployment, integration, and testing. **III:** Expressions for giving technical opinions and discussing design trade-offs. **IV:** Writing: Process description for a software or hardware system.

Learning Outcomes I: Students use the passive voice to describe how systems are designed, built, tested, and deployed, participating in technical discussions about engineering processes.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.6 Debugging and Analysis, 12 hr(s)

Competences: AG-A04

Topics: **I:** Past Continuous vs. Simple Past in incident and failure reports. **II:** Narrative and sequence connectors: while, when, suddenly, as a result. **III:** Vocabulary: Bugs, exceptions, crashes, logs, root cause analysis. **IV:** Writing: Incident report for a software or network failure.

Learning Outcomes I: Students narrate debugging sessions, system failures, and experimental incidents using narrative tenses and technical sequencing connectors fluently.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.7 Research and Innovation, 12 hr(s)

Competences: AG-A04

Topics: **I:** Future Forms: Will, Going to, Present Continuous for research projection. **II:** Expressions of probability and certainty in scientific contexts. **III:** Vocabulary: Innovation cycles, research proposals, technology forecasting. **IV:** Oral presentations: "The future of computing in my field".

Learning Outcomes I: Students project research goals and discuss future directions in computing and engineering using various future structures with appropriate degrees of certainty.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.8 Technical English III, 12 hr(s)

Competences: AG-A04

Topics: **I:** Programming and Web Development terminology: functions, APIs, frameworks. **II:** User Interface (UI/UX) descriptions and usability concepts. **III:** Basic project management vocabulary: sprints, milestones, deliverables. **IV:** Writing: Simple technical specification or README document.

Learning Outcomes **I:** By the end of the course, students use specialized software development vocabulary to describe logical and functional components and produce basic technical documentation in English.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

6. Bibliography

[Cambridge, 2006] Cambridge (2006). *Diccionario Inglés-Espanol Cambridge*. Editorial Oxford.

[MacGrew, 1999] MacGrew, J. (1999). *Focus on Grammar Basic*. Editorial Oxford.

[Soars and John, 2002d] Soars, L. and John (2002d). *American Headway N 2 Student Book*. Editorial Oxford.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG363 Ecology and Sustainable Development (Mandatory)

1. General information

- **Semester**: 4th Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

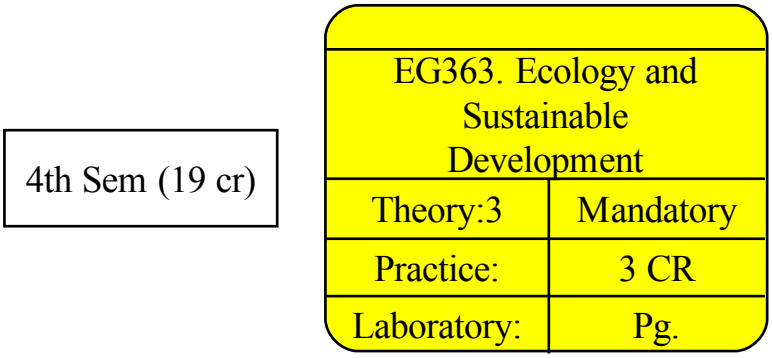


Figure 3.27: Connection Map. EG363 Ecology and Sustainable Development

2. Course Rationale

Ecología y Desarrollo Sostenible pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito la comprensión de la interrelación entre los seres vivos y el medio ambiente, así como la repercusión de la problemática ambiental del mundo actual con el desarrollo de la vida y con el desarrollo económico y social, enfatizando en la comprensión de la responsabilidad del estudiante como persona y como profesional. Comprende los principios y conceptos de la ecología, los ecosistemas y la biodiversidad, la problemática ambiental y el cambio climático, la contaminación y los recursos naturales, y el desarrollo sostenible aplicado a la arquitectura.

3. Goals of the Course

- Analizar los principios y conceptos fundamentales de la ecología, relacionando los componentes, procesos e interacciones de los ecosistemas con el equilibrio de los sistemas naturales.
- Analizar los principales problemas ambientales y sus efectos sobre los ecosistemas y la sociedad, considerando sus causas, consecuencias y alternativas de prevención y mitigación.
- Analizar estrategias y soluciones de desarrollo sostenible, relacionándolas con los ODS, la responsabilidad social y su aplicación en el ámbito arquitectónico.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Usage)

AG-A13) Demonstrates knowledge of the means to achieve ecologically responsible design and environmental conservation and rehabilitation. (Usage)

5. Content

5.1 La Ecología. Principios y Conceptos, 15 hr(s)

Competences: AG-A01

Topics: **I:** Ecología: definición, objeto de estudio e importancia. Principios y conceptos fundamentales. Niveles de organización ecológica: individuo, población, comunidad, ecosistema y biosfera. Relación entre los seres vivos y su ambiente: factores bióticos y abióticos. **II:** Ecosistema: definición, estructura y componentes. Tipos de ecosistemas y sus características. Ecosistemas del Perú: costeros, andinos y amazónicos. **III:** Biodiversidad: concepto, niveles e importancia. Hábitat y nicho ecológico. Relaciones ecológicas entre los seres vivos. **IV:** Flujo de materia y energía en los ecosistemas. Ciclos biogeoquímicos: agua, carbono y oxígeno. Interacción humana y alteración de los ecosistemas. Uso y agotamiento de los recursos naturales.

Learning Outcomes **I:** Analiza la ecología: definición, objeto de estudio e importancia, y los niveles de organización ecológica (individuo, población, comunidad, ecosistema y biosfera). [Usage]. **II:** Identifica componentes de los ecosistemas, reconoce ecosistemas del Perú (costeros, andinos y amazónicos) y analiza las relaciones bióticas y abióticas. [Usage]. **III:** Identifica niveles de biodiversidad, diferencia hábitat y nicho ecológico, y analiza la importancia de la biodiversidad para el equilibrio de los ecosistemas. [Usage]. **IV:** Interpreta ciclos biogeoquímicos (agua, carbono y oxígeno), identifica impactos de la interacción humana sobre los ecosistemas y analiza el uso y agotamiento de los recursos naturales. [Usage].

Bibliography: [Malacalza, 2013, Begon and Townsend, 2021]

5.2 Problemas Ambientales, 21 hr(s)

Competences: AG-A13

Topics: **I:** Problemática ambiental: concepto y características. Relación entre las actividades humanas y el ambiente. Principales problemas ambientales globales y locales. **II:** Cambio climático: definición y causas. Efecto invernadero y calentamiento global. Consecuencias del cambio climático. Adaptación y mitigación. ODS 13: Acción por el clima. **III:** Contaminación ambiental: concepto, tipos y fuentes. Contaminación del aire, agua y suelo. Residuos sólidos: clasificación, manejo, reciclaje y reutilización. **IV:** Recursos naturales: clasificación y características. Uso, sobreexplotación y agotamiento. Recursos hídricos del Perú. Deforestación, sobrepesca, sobreexplotación minera, desertificación y erosión. **V:** Ecorregiones del Perú y problemática ambiental. Áreas Naturales Protegidas. Política y legislación ambiental en el Perú.

Learning Outcomes **I:** Analiza lecturas sobre problemática ambiental, identificando problemas ambientales globales y locales y la relación entre las actividades humanas y el ambiente. [Usage]. **II:** Diferencia entre cambio climático y calentamiento global, identificando causas y consecuencias, y relacionándolo con el ODS 13 (acción por el clima). [Usage]. **III:** Identifica fuentes y tipos de contaminación (aire, agua y suelo), reconoce focos contaminantes y propone medidas de prevención y control. [Usage]. **IV:** Clasifica los recursos naturales e identifica problemáticas ambientales del Perú (deforestación, sobrepesca, sobreexplotación minera, desertificación, erosión). [Usage]. **V:** Identifica problemáticas ambientales en las ecorregiones del Perú y analiza instrumentos de política y legislación ambiental, incluyendo las Áreas Naturales Protegidas. [Usage].

Bibliography: [Intergovernmental Panel on Climate Change, 2023, Ministerio del Ambiente, 2024]

5.3 Desarrollo Sostenible, 18 hr(s)

Competences: AG-A01

Topics: I: Desarrollo sostenible: definición, principios e importancia. Diferencia entre sostenibilidad y desarrollo sostenible. Dimensiones de la sostenibilidad: ambiental, social y económica. Agenda 2030 y Objetivos de Desarrollo Sostenible. Responsabilidad Social Universitaria. **II:** Sostenibilidad aplicada a la arquitectura: arquitectura sostenible y bioclimática. Estrategias pasivas y activas para el diseño sostenible. Eficiencia energética y uso eficiente de recursos. Certificaciones de sostenibilidad en la edificación. **III:** Innovación y sostenibilidad en la vivienda y el entorno urbano: Solar Decathlon. Diseño y construcción de viviendas sostenibles. Buenas prácticas de sostenibilidad aplicables al espacio urbano. **IV:** Desarrollo de estrategias de mejora para el espacio urbano estudiado. Sustentación de la investigación y propuesta desarrollada.

Learning Outcomes I: Analiza lecturas relacionadas con desarrollo sostenible, diferenciando sostenibilidad y desarrollo sostenible, e identificando sus dimensiones (ambiental, social y económica). [Usage]. **II:** Identifica estrategias de diseño sostenible y bioclimático, y reconoce estrategias de eficiencia energética y uso responsable de recursos aplicadas a la arquitectura. [Usage]. **III:** Identifica y analiza estrategias y tecnologías sostenibles aplicadas a la vivienda y al entorno urbano (Solar Decathlon), analizando buenas prácticas de sostenibilidad aplicables al espacio urbano. [Usage]. **IV:** Desarrolla estrategias de mejora para un espacio urbano estudiado, sustentando una investigación y propuesta de buenas prácticas de sostenibilidad. [Assessment].

Bibliography: [Naciones Unidas, 2015, Garrido, 2013]

6. Bibliography

[Begon and Townsend, 2021] Begon, M. E. and Townsend, C. R. (2021). *Ecology: From Individuals to Ecosystems*. Wiley-Blackwell, 5th edition.

[Garrido, 2013] Garrido, L. D. (2013). *Arquitectura para la Felicidad: Ecológica, Sostenible, Bioclimática*. Instituto Monsa de Ediciones.

[Intergovernmental Panel on Climate Change, 2023] Intergovernmental Panel on Climate Change (2023). Climate change 2023: Synthesis report. Technical report, IPCC.

[Malacalza, 2013] Malacalza, L. (2013). *Ecología y Ambiente*. Asociación de Universidades Grupo Montevideo & Universidad Nacional de La Plata.

[Ministerio del Ambiente, 2024] Ministerio del Ambiente (2024). Política nacional: Estrategia nacional ante el cambio climático al 2050. Technical report, Ministerio del Ambiente.

[Naciones Unidas, 2015] Naciones Unidas (2015). Transformar nuestro mundo: La agenda 2030 para el desarrollo sostenible. Technical report, Naciones Unidas.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

EG365 Peru's Problems and Challenges in a Global World (Mandatory)

1. General information

- **Semester**: 4th Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

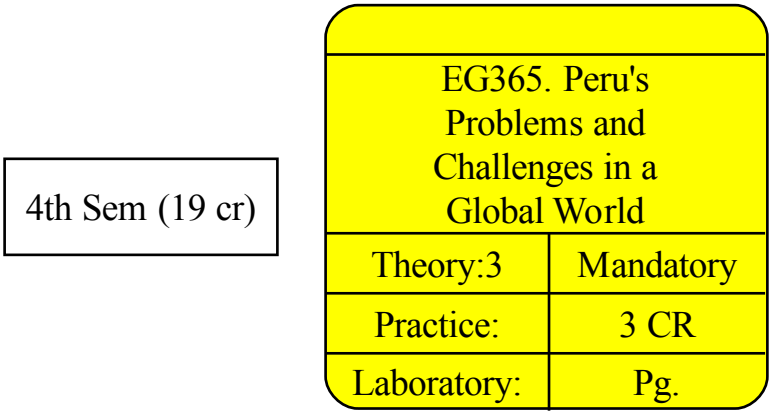


Figure 3.28: Connection Map. EG365 Peru's Problems and Challenges in a Global World

2. Course Rationale

Problemas y Desafíos del Perú en un Mundo Global pertenece al Área de Estudios Generales, es de carácter obligatorio y de naturaleza teórica. Tiene como propósito la comprensión de los problemas sociopolíticos que enfrenta el Perú y que son desafíos para su desarrollo y progreso, en el contexto de la sociedad global del siglo XXI. Comprende el Estado peruano y la gobernabilidad, el desarrollo político y la democracia, los regímenes políticos, el Estado y la crisis de representatividad, la economía social de mercado y la corrupción, la diversidad social y las brechas y desigualdades, y los procesos de producción, inflación, globalización y comercio internacional.

3. Goals of the Course

- Identificar las principales características del territorio y los recursos naturales del Perú, y analizar los principales problemas sociales de su entorno en relación con las metas de los Objetivos de Desarrollo Sostenible de la ONU.
- Analizar la naturaleza de los regímenes políticos y su relación con la gobernabilidad, y la problemática de la corrupción y su impacto en la economía.
- Analizar la producción nacional y los sectores clave para el desarrollo del país, y evaluar los indicadores de la globalización y los elementos del comercio internacional.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Usage)

5. Content

5.1 Realidad Nacional, Responsabilidad Social y Sociedad, 15 hr(s)

Competences: AG-A01

Topics: **I:** Realidad nacional: definiciones, población, megadiversidad, ecología, identidad, soportes de la cultura. **II:** Responsabilidad social: definiciones, elementos, agentes, normativa, responsabilidad social empresarial. Objetivos de Desarrollo Sostenible de la ONU. Planificación: políticas, elementos. **III:** Sociedad: orígenes, fases de la socialización, agentes. Diversidad cultural. Procesos migratorios internos y externos: migración del campo a la ciudad, migraciones internacionales, efectos y problemas actuales. **IV:** Diversidad social: brechas, discriminación y desigualdades; género, personas con habilidades diferentes y población adulto mayor.

Learning Outcomes **I:** Reconoce la gran variedad de la biodiversidad e identidad cultural del país, a través de talleres y estudios de caso sobre realidad nacional. [Usage]. **II:** Comprende el compromiso de individuos e instituciones con la sociedad en el logro de las metas de los ODS N.º 3 y N.º 13 de la ONU, elaborando un plan de responsabilidad social. [Usage]. **III:** Reconoce los agentes de socialización y su influencia, y analiza los procesos migratorios internos y externos y sus efectos. [Usage]. **IV:** Identifica brechas, discriminación y desigualdades sociales, incluyendo las variables de género, discapacidad y adulto mayor, elaborando una monografía sobre realidad nacional, sociedad y responsabilidad social. [Usage].

Bibliography: [y León, 2012, et al., 2021]

5.2 Regímenes Políticos, Estado, Economía y Corrupción, 21 hr(s)

Competences: AG-A01

Topics: **I:** Regímenes políticos: definiciones, características, partidos políticos, ideologías. Problemática de los partidos políticos. **II:** Estado: estructura, agentes, funciones, gobiernos. Gobernabilidad. Las instituciones del Estado y la crisis de representatividad. **III:** Economía social de mercado: definición, políticas económicas, instrumentos y agentes. **IV:** Políticas aplicadas en diferentes gobiernos: efectos y consecuencias. Avances en democracia y gobernanza democrática en el mundo globalizado y desafíos para el Perú. **V:** La corrupción: definición, características, consecuencias sociales. Implicancias y retos para enfrentar la corrupción.

Learning Outcomes **I:** Identifica las características y elementos de los regímenes políticos y sus ideologías, y analiza la problemática de los partidos políticos mediante taller y resolución de casos. [Usage]. **II:** Identifica la estructura del Estado peruano, la participación de los partidos políticos, y analiza la crisis de representatividad institucional mediante talleres y estudios de caso. [Usage]. **III:** Analiza el modelo económico del Perú (economía social de mercado) y los instrumentos de las políticas económicas, mediante taller y resolución de casos sobre economía. [Usage]. **IV:** Analiza los distintos gobiernos, sus políticas, formas de gobierno y los avances en gobernanza democrática, elaborando una monografía sobre regímenes políticos, economía y corrupción. [Usage]. **V:** Analiza las consecuencias económicas y sociales de la corrupción y los retos para enfrentarla, mediante taller y resolución de casos sobre corrupción. [Usage].

Bibliography: [Durand, 2018, Parodi, 2022]

5.3 Producción, Inflación, Globalización y Comercio Internacional, 18 hr(s)

Competences: AG-A01

Topics: **I:** Producción: definiciones, fases, sectores productivos, el empleo, agentes. **II:** Inflación: definiciones, clasificación. **III:** La globalización: definiciones, etapas, internacionalización. Comercio exterior e internacional: definiciones, características, importaciones y exportaciones.

Learning Outcomes I: Analiza las fases de la producción y los sectores clave que generan ingresos y desarrollo al país, mediante talleres sobre producción. [Usage]. **II:** Analiza las causas de un proceso inflacionario, mediante taller sobre inflación. [Usage]. **III:** Evalúa la realidad del Perú frente a la globalización e identifica los principales productos negociados mediante importaciones y exportaciones, entregando una monografía final sobre producción, inflación, globalización y comercio internacional. [Assessment].

Bibliography: [Krugman et al., 2012, Ríos, 2010]

6. Bibliography

[Durand, 2018] Durand, F. (2018). *Odebrecht, la Empresa que Capturaba Gobiernos*. Fondo Editorial PUCP.

[et al., 2021] et al., A. H. (2021). *Realidad Peruana*. Editorial Summa.

[Krugman et al., 2012] Krugman, P., Obstfeld, M., and Melitz, M. (2012). *Economía Internacional*. Editorial Pearson, 9th edition.

[Parodi, 2022] Parodi, C. (2022). *Economía Política y Sociedad*. Editorial Universidad del Pacífico.

[Ríos, 2010] Ríos, J. (2010). Globalización y sociedad peruana. In *Realidad, Nacional. Sociedad, Estado y Cultura en el Perú Contemporáneo*. Editorial Universidad Ricardo Palma.

[y León, 2012] y León, C. A. (2012). *El Perú Nuestro de Cada Día. Nueve Ensayos para Discutir y Decidir*. Editorial Universidad del Pacífico, 2nd edition.

Fifth Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2B3 BIM Scheduling and Cost (Mandatory)

1. General information

- **Semester**: 5th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2B2 BIM Execution Planning (4th Sem-Pg. 116)

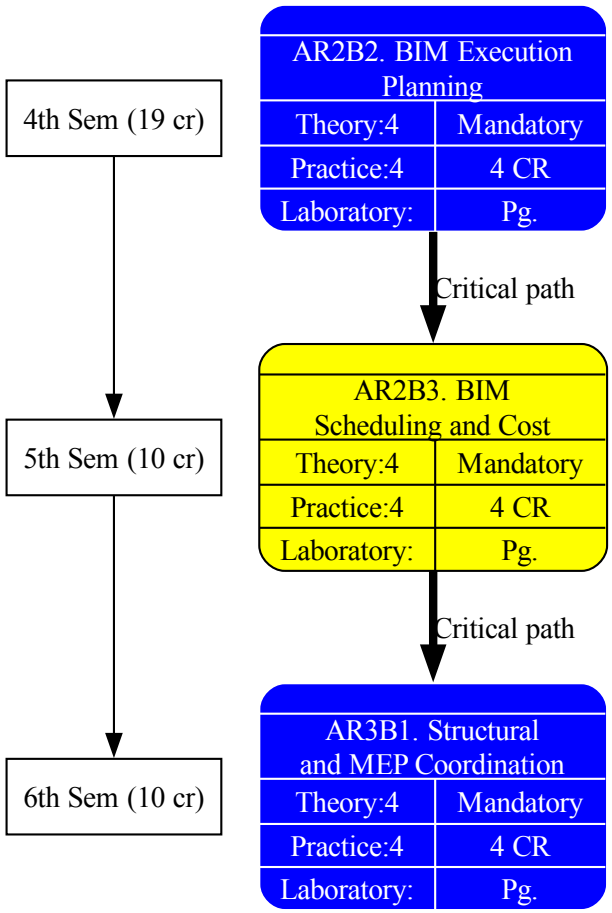


Figure 3.29: Connection Map. AR2B3 BIM Scheduling and Cost

2. Course Rationale

BIM Scheduling and Cost is the fifth course of the mandatory BIM I-X sequence, building directly on the authoring and multidisciplinary coordination skills developed through AR2B2. It moves the student from a purely geometric and coordination-oriented use of the BIM model into its project-controls dimension: linking the model to time (4D scheduling) and cost (5D estimating), and then

overlaying Lean Construction management principles – the Last Planner System and pull planning – onto that linked model to improve the reliability of construction sequencing. This course is what equips students to use BIM not just to design and coordinate a building, but to plan, cost, and manage its actual construction, preparing them for the professional-practice and construction-administration content later in the curriculum.

3. Goals of the Course

- Use 4D BIM to link model elements to a construction schedule, producing sequencing simulations for constructability review and stakeholder communication.
- Extract quantities from a BIM model and link them to unit costs to produce model-based 5D cost estimates across design iterations.
- Apply Lean Construction principles – Last Planner System and pull planning – integrated with a 4D BIM schedule to reduce waste and improve the reliability of construction sequencing.
- Build proficiency in BIM scheduling, cost-estimation, and coordination software through a guided, certification-aligned practicum.

4. General Competences (*Outcomes*)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Usage)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A14) Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture. (Usage)

5. Content

5.1 4D BIM and Construction Scheduling, 24 hr(s)

Competences: AG-A05

Topics: I: 4D BIM and construction scheduling: linking BIM elements to Gantt chart activities in Synchro or Navisworks TimeLiner **II:** Construction sequencing simulation: visualizing phased construction, logistics, and site congestion through 4D animation for stakeholder communication and constructability review

Learning Outcomes I: Describe the concept of 4D BIM and explain how linking model elements to schedule activities supports construction planning and communication [Familiarity] **II:** Link a BIM model's elements to a construction schedule to produce a 4D sequencing simulation for a building project [Usage] **III:** Evaluate a 4D construction sequencing simulation for its accuracy, clarity, and usefulness in identifying logistics or site-congestion problems [Assessment]

Bibliography: [Issa et al., 2003]

5.2 5D BIM and Cost Estimation, 24 hr(s)

Competences: AG-A05

Topics: I: Model-based quantity takeoff and cost estimation: automated schedule extraction from BIM elements, level of development (LOD) requirements for cost estimation **II:** 5D cost modeling: linking BIM quantities to unit costs for real-time budget tracking across design iterations, and change-order cost impact analysis

Learning Outcomes I: Describe how BIM-based quantity takeoff supports cost estimation, and explain the relationship between model LOD and estimate accuracy [Familiarity] **II:** Extract quantities from a BIM model and link them to unit costs to produce a model-based cost estimate for a design option [Usage] **III:** Evaluate a 5D cost model for completeness and accuracy, identifying quantities that are missing, duplicated, or misclassified [Assessment]

Bibliography: [Eastman et al., 2018]

5.3 Lean Construction and 4D BIM Integration, 24 hr(s)

Competences: AG-A05,AG-A14

Topics: **I:** Last Planner System: pull planning, weekly work plans, and percent-plan-complete (PPC) tracking, and its integration with a 4D BIM schedule **II:** Collaborative pull-planning sessions using 4D BIM visualizations to sequence trade work and identify constraints before they cause delay **III:** Lean waste-reduction principles (overproduction, waiting, rework) applied to BIM-coordinated construction workflows

Learning Outcomes **I:** Describe the Last Planner System and explain how linking it to a 4D BIM schedule improves the reliability of construction sequencing [Familiarity] **II:** Run a pull-planning exercise supported by a 4D BIM visualization, producing a weekly work plan and identifying constraints [Usage] **III:** Evaluate a Lean-BIM construction plan for its percent-plan-complete tracking and its effectiveness at surfacing constraints before they cause delay [Assessment]

Bibliography: [Tzortzopoulos et al., 2020]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: **I:** Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes **I:** Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Hardin and McCool, 2015]

6. Bibliography

[Eastman et al., 2018] Eastman, C., Teicholz, P., Sacks, R., and Liston, K. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors*. Wiley, 3rd edition.

[Hardin and McCool, 2015] Hardin, B. and McCool, D. (2015). *BIM and Construction Management: Proven Tools, Methods, and Workflows*. Sybex, 2nd edition.

[Issa et al., 2003] Issa, R. R. A., Flood, I., and O'Brien, W. J., editors (2003). *4D CAD and Visualization in Construction: Developments and Applications*. A.A. Balkema Publishers, 1st edition.

[Tzortzopoulos et al., 2020] Tzortzopoulos, P., Kagioglou, M., and Koskela, L., editors (2020). *Lean Construction: Core Concepts and New Frontiers*. Routledge, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2D2 Design Studio V (Mandatory)

1. General information

- **Semester**: 5th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2D1 Design Studio IV (4th Sem-Pg. 119)

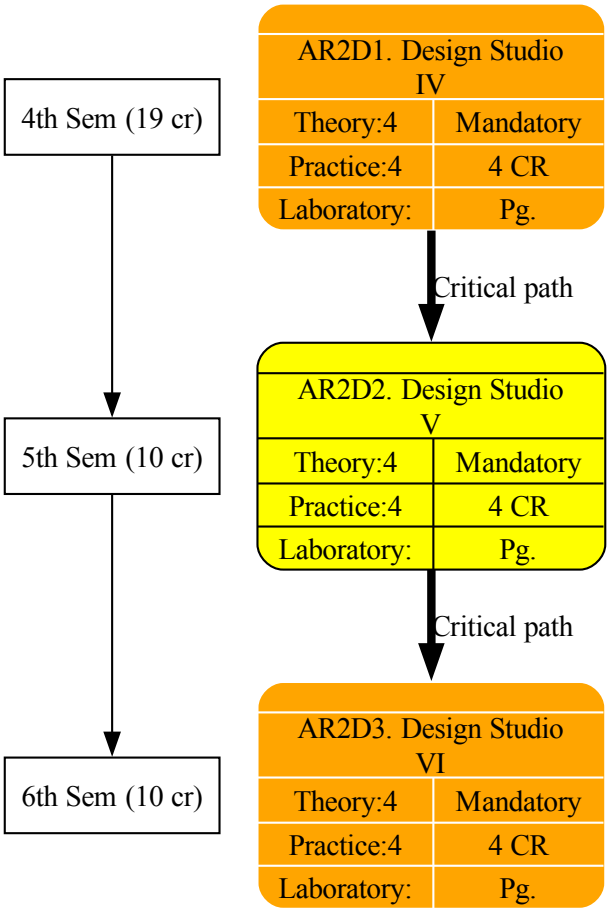


Figure 3.30: Connection Map. AR2D2 Design Studio V

2. Course Rationale

Design Studio V: Educational/Cultural Building develops a medium-scale building with a markedly more complex program than Design Studio IV (AR2D1, prerequisite) – a school, library, or small cultural center – in which an explicit long-span structural system and a deliberately performance-driven design process generate, rather than merely accommodate, the architectural proposal. The studio asks students to resolve daylight, acoustic, and mechanical comfort criteria for spaces with specific performance requirements (classrooms, auditoria, galleries), and to detail a high-performance

building envelope that supports those criteria. This course is the foundation for Design Studio VI (AR2D3).

3. Goals of the Course

- Design a long-span structural system (trusses, arches, shells, or space frames) appropriate to the spatial requirements of a mid-sized educational or cultural building.
- Integrate environmental and structural performance criteria as generative drivers of the design proposal from the earliest design stages.
- Design apertures and shading for adequate daylight performance in classrooms, galleries, and other program-specific spaces.
- Resolve acoustic performance requirements (reverberation, isolation) appropriate to the program's specific spaces.
- Select and coordinate mechanical (HVAC) systems with the architectural design.
- Detail a high-performance building envelope that supports the building's daylight, thermal, and acoustic performance goals.

4. General Competences (*Outcomes*)

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)

AG-A11) Demonstrates knowledge of the physical problems and technologies that allow buildings to provide internal comfort and protection within environmental parameters. (Usage)

AG-A14) Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture. (Usage)

5. Content

5.1 Long-Span and Special Structures, 10 hr(s)

Competences: AG-A08

Topics: **I:** Arches and vaults: funicular compression geometry, buttressing requirements, ribbed vs. continuous vaults, and historic and contemporary applications (Guastavino, Candela) **II:** Domes and shells: membrane theory, edge ring forces, buckling in thin shells, geodesic domes (Fuller), and reinforced concrete shells (Nervi, Isler) **III:** Space frames and long-span trusses: three-dimensional truss action, node design, modular systems (Mero, Unistrut), and application in arenas, airports, and exhibition halls **IV:** Tensile and cable structures: cable nets (Frei Otto), fabric membranes (PTFE-coated fiberglass, ETFE), masts and anchorage design, and form-finding via physical **V:** Folded plate structures: corrugated geometry for stiffness, folded plate concrete roofs, and timber folded plate systems (CLT folded plates) **VI:** Deployable and transformable structures: scissor linkages, pantographic systems, and their application in retractable roofs, emergency shelters, and kinetic architecture

Learning Outcomes **I:** Describe the principal long-span structural systems - arches, domes, space frames, tensile membranes - and identify the appropriate span range [Familiarity] **II:** Select and conceptualize a long-span structural system for a given program (e.g., stadium, airport terminal, convention center), justifying the choice by span, load, [Usage] **III:** Evaluate the structural efficiency and architectural expression of a built long-span structure, analyzing its load path, stability, and integration of form with structural logic [Assessment]

Bibliography: [Schierle, 2012]

5.2 Performance-Driven Design, 10 hr(s)

Competences: AG-A08

Topics: **I:** Integration of performance criteria into early design: using daylighting, solar access, thermal comfort, and structural efficiency as spatial **II:** Simulation-based design feedback: using tools such as Ladybug, Honeybee, and Grasshopper to evaluate energy, daylight, **III:** Passive design strategies: solar shading, natural ventilation, thermal mass, and orientation as architectural design elements that reduce mechanical energy loads **IV:** Structural form-finding as design: integrating structural logic (arches, shells, trusses, tensile systems) into spatial and formal decisions from schematic design onward **V:** Building performance metrics and certification frameworks: EUI (energy use intensity), daylight autonomy, thermal comfort indices (PMV, SET), **VI:** AI-assisted performance optimization: generative adversarial networks and reinforcement learning for multi-objective design optimization

Learning Outcomes **I:** Identify the key environmental and structural performance criteria relevant to a design project and describe how they can inform early-stage spatial and formal decisions [Familiarity] **II:** Apply passive design strategies and simulation feedback to develop a performance-informed architectural proposal that meets defined energy and comfort targets [Usage] **III:** Evaluate a building design for environmental and structural performance using simulation outputs and standard metrics, and propose targeted design improvements [Assessment]

Bibliography: [Lechner, 2014]

5.3 Daylighting and Visual Comfort, 8 hr(s)

Competences: AG-A11

Topics: **I:** Daylight performance metrics: daylight factor (DF), spatial daylight autonomy (sDA), annual sunlight exposure (ASE), useful daylight illuminance (UDI), and glare indices (DGP, DGI) **II:** Aperture design for daylight: window-to-wall ratio (WWR), head height, sill height, clerestories, sawtooth roofs, light shelves, **III:** Shading integration for glare and cooling: fixed (overhangs, fins, louvers), operable (roller shades, venetian blinds, screens), **IV:** Daylight simulation tools: climate-based modeling (Radiance, DIVA, ClimateStudio, Ladybug Tools); annual simulation for LEED and other certification credits **V:** Electric lighting integration: daylight harvesting controls (dimming, stepped switching), task-ambient lighting strategies,

Learning Outcomes **I:** Describe the principal daylight performance metrics (sDA, ASE, UDI) and explain how they inform aperture and shading design decisions [Familiarity] **II:** Design and simulate a daylighting strategy for a building facade or roof aperture, iterating on WWR, orientation, and shading to meet defined sDA and ASE targets [Usage] **III:** Evaluate a building's daylighting design from simulation outputs, identifying areas of glare or insufficient illuminance [Assessment]

Bibliography: [Lechner, 2014]

5.4 Acoustics and Noise Control, 8 hr(s)

Competences: AG-A11

Topics: **I:** Sound measurement metrics: sound pressure level (SPL, dB), A-weighting (dBA), reverberation time (RT_{60}), sound transmission class (STC), impact insulation class (IIC), **II:** Absorption and diffusion: porous absorbers (fiberglass, foam), resonant absorbers (perforated panels, membrane), and diffusers (quadratic residue, binary amplitude) **III:** Sound isolation and flanking paths: mass-law, double-wall and decoupled assemblies, sealed penetrations, gasketed doors, floating floors, **IV:** Room acoustic design: calculating RT_{60} from volume and absorption, early decay time (EDT), clarity (C50, C80), and speech intelligibility (STI) for auditoria, classrooms, **V:** Noise control from external sources: site planning for noise barriers, facade STC selection based on exterior noise levels (road, rail, air),

Learning Outcomes **I:** Describe the key acoustic metrics (STC, IIC, RT60, NC) and explain how each influences the design of building assemblies and room finishes [Familiarity] **II:** Design a wall and floor-ceiling assembly to meet a specified STC and IIC rating, detailing flanking path controls

and penetrations to achieve target isolation [Usage] **III:** Evaluate a room's acoustic design by calculating its reverberation time and comparing it to recommended values for its intended use (lecture, music, conferencing) [Assessment]

Bibliography: [Mehta et al., 1999]

5.5 Mechanical Systems (HVAC), 8 hr(s)

Competences: AG-A11

Topics: I: HVAC system classification: all-air (VAV, CAV, dual-duct), all-water (fan-coil, radiant), air-water (induction), and decentralized (heat pumps, PTAC, split systems) **II:** Thermal zoning and load calculation: zone definition by orientation, occupancy, and use; heating and cooling load components (sensible, latent); peak load vs. part-load performance **III:** Distribution system integration: ceiling plenum depth for ducts, raised floors for underfloor air distribution (UFAD), vertical riser coordination, **IV:** Dedicated outdoor air systems (DOAS) and energy recovery: enthalpy wheels, run-around loops, and heat pipes **V:** High-efficiency HVAC technologies: variable refrigerant flow (VRF), chilled beams (active and passive), displacement ventilation, radiant heating and cooling slabs,

Learning Outcomes I: Identify the principal HVAC system types and describe the architectural implications of each in terms of floor-to-floor height, ceiling plenum, mechanical room space, [Familiarity] **II:** Select an appropriate HVAC system type for a building program and climate zone, integrating thermal zoning and distribution layout into the architectural floor plan and section [Usage] **III:** Evaluate the HVAC system layout of a building for efficiency, constructability, and architectural integration [Assessment]

Bibliography: [Lechner, 2014]

5.6 Facade and Building Envelope Technology, 12 hr(s)

Competences: AG-A14

Topics: I: Envelope performance criteria: thermal transmittance (U-value), solar heat gain coefficient (SHGC), air infiltration, acoustic transmission loss, **II:** Glazing systems: double and triple glazing, low-e coatings, electrochromic and thermochromic glass, structural silicone glazing, and point-fixed glazing **III:** Curtain wall and rainscreen systems: pressure-equalized rainscreen principle, back-ventilated facades, unitized curtain wall panels, and the detailing of movement joints **IV:** Insulation and airtightness: continuous insulation strategies for thermal bridge elimination, air barrier systems, blower-door testing, and Passivhaus envelope standards **V:** Opaque wall systems: masonry veneer, EIFS, precast concrete panels, metal panels, and fiber cement; fire rating, moisture management, and structural attachment for each system **VI:** Responsive and dynamic facade systems: kinetic facades (louvered, origami, pneumatic), electrochromic and BIPV panels, and media facades

Learning Outcomes I: Describe the main types of building envelope systems and their performance characteristics, including thermal, moisture, acoustic, and solar control properties [Familiarity] **II:** Select and detail an appropriate building envelope system for a specific climate and building program, justifying the choice in terms of performance, cost, and constructability [Usage] **III:** Evaluate a facade design for thermal, moisture, and solar performance, identifying deficiencies in detailing and proposing improvements to meet defined performance targets [Assessment]

Bibliography: [Allen and Iano, 2019]

6. Bibliography

[Allen and Iano, 2019] Allen, E. and Iano, J. (2019). *Fundamentals of Building Construction: Materials and Methods*. Wiley, 7th edition.

[Lechner, 2014] Lechner, N. (2014). *Heating, Cooling, Lighting: Sustainable Design Methods for Architects*. Wiley, 4th edition.

[Mehta et al., 1999] Mehta, M., Johnson, J., and Rocafort, J. (1999). *Architectural Acoustics: Principles and Design*. Prentice Hall.

[Schierle, 2012] Schierle, G. G. (2012). *Architectural Structures*. University of Southern California.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

ID202 Technical and professional English IV (Mandatory)

1. General information

- **Semester**: 5th Sem. **Credits**: 2
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 2 hours;
- **Prerrequisites**:
  - ID201 Technical and professional English III (4th Sem-Pg. 123)

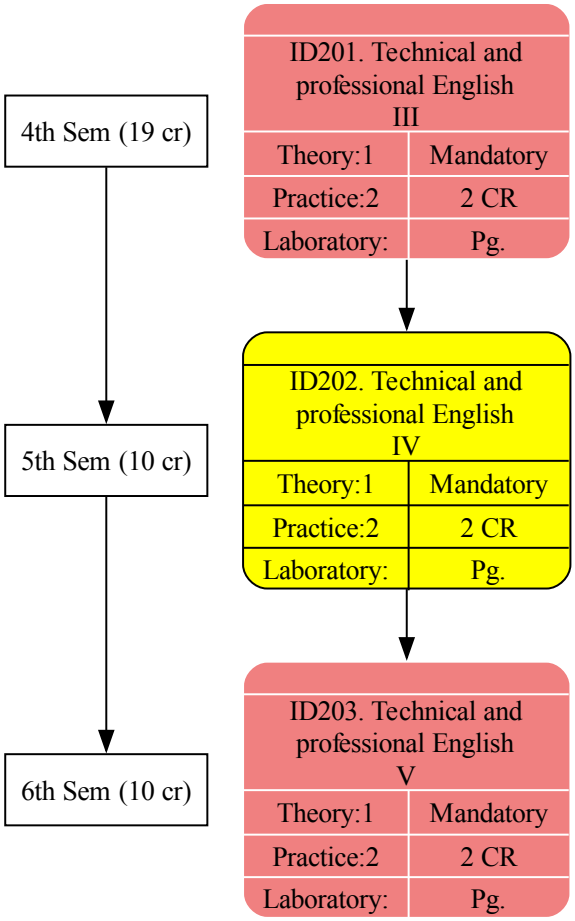


Figure 3.31: Connection Map. ID202 Technical and professional English IV

2. Course Rationale

At the intermediate level, students apply English to the full range of technical communication required in computing and engineering practice: reading research papers, writing structured technical documents, analyzing case studies, and engaging in professional dialogue. Grammar structures are taught through authentic computing and engineering contexts, reinforcing both linguistic competence and disciplinary knowledge.

3. Goals of the Course

- Develop the ability to write and read structured technical documents in English.
- Bring the student to a more fluent and natural expression in technical and scientific English.
- Master vocabulary for computing, systems engineering, and applied sciences.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

5. Content

5.1 Best Practices and Ethics, 12 hr(s)

Competences: AG-A04

Topics: I: Modals of obligation and advice: Should, Must, Have to in engineering codes. **II:** Prohibition and absence of obligation in software licensing and data privacy. **III:** Vocabulary: Professional ethics, intellectual property, responsible AI. **IV:** Writing: Formal technical recommendation and policy documents.

Learning Outcomes I: By the end of the unit, students correctly use modal auxiliaries to express engineering standards, ethical obligations, and professional recommendations in formal technical environments.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.2 Failures and Root Causes, 12 hr(s)

Competences: AG-A04

Topics: I: Past Perfect: Structure and use in root cause analysis and post-mortems. **II:** Contrast between Simple Past, Continuous, and Perfect in failure timelines. **III:** Vocabulary: System outages, security breaches, cascading failures. **IV:** Expressions for reporting information: reported speech in incident briefings.

Learning Outcomes I: Students reconstruct complex failure timelines and root cause analyses by establishing clear chronological sequences through the use of past tense contrasts.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.3 If-Then Logic, 12 hr(s)

Competences: AG-A04

Topics: I: Conditionals Type 0, 1, and 2 applied to computing logic and engineering decisions. **II:** Sentences with "If" and "Unless" for system constraints and requirements. **III:** Vocabulary: Hypothetical scenarios, risk analysis, and optimization trade-offs. **IV:** Expressions of what-if design thinking: "If we used X, the system would..."

Learning Outcomes I: Students pose real and hypothetical technical scenarios and their consequences, using conditional structures to reason about design choices and engineering decisions.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.4 Ongoing Research, 12 hr(s)

Competences: AG-A04

Topics: **I:** Present Perfect Continuous for describing research in progress. **II:** Contrast between Simple and Continuous Present Perfect in scientific writing. **III:** Vocabulary: Continuous integration, agile development, iterative research. **IV:** Word formation: Prefixes and suffixes in scientific and technical terminology.

Learning Outcomes **I:** Students describe research activities and development processes that began in the past and continue into the present, emphasizing duration and iterative progress.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.5 Manufacturing and Deployment, 12 hr(s)

Competences: AG-A04

Topics: **I:** Passive Voice in all basic tenses for technical process descriptions. **II:** Verbs with two objects in passive: data is sent to the server by the client. **III:** Vocabulary: Hardware manufacturing, cloud deployment, CI/CD pipelines. **IV:** Writing: Technical description of a deployment or production process.

Learning Outcomes **I:** Students use the passive voice across multiple tenses to describe technical processes where the action, system, or result is the focus rather than the agent.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.6 Tech Roadmaps, 12 hr(s)

Competences: AG-A04

Topics: **I:** Future Continuous and Future Perfect for project timelines and milestones. **II:** Adverbs of probability: perhaps, probably, definitely — in tech forecasting. **III:** Vocabulary: Product roadmaps, release planning, emerging research areas. **IV:** Oral presentations: "The state of AI / quantum computing in 5 years".

Learning Outcomes **I:** Students project technical states, completed future milestones, and research outcomes, discussing computing and engineering roadmaps with advanced vocabulary.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.7 Technical Teams, 12 hr(s)

Competences: AG-A04

Topics: **I:** Indirect questions and Tag questions in technical interviews and peer reviews. **II:** Common Phrasal Verbs in engineering and research environments. **III:** Vocabulary: Collaboration tools, code review practices, team roles. **IV:** Writing: Short technical blog posts and engineering team updates.

Learning Outcomes **I:** Students use polite inquiry forms and confirmation strategies in technical interviews and team discussions, improving their fluency and naturalness in professional engineering contexts.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

5.8 Technical English IV: Networks and Security, 12 hr(s)

Competences: AG-A04

Topics: I: Networking terminology: protocols, topologies, OSI model, routing. **II:** Cybersecurity vocabulary: vulnerabilities, threats, encryption, authentication. **III:** Reading and writing network incident and security audit reports. **IV:** Project: Security assessment plan for a computing infrastructure.

Learning Outcomes I: By the end of the course, students command networking and cybersecurity technical terminology to read specialized documentation and communicate effectively with IT and security professionals in English.

Bibliography: [Soars and John, 2002d, Cambridge, 2006, MacGrew, 1999]

6. Bibliography

[Cambridge, 2006] Cambridge (2006). *Diccionario Inglés-Espanol Cambridge*. Editorial Oxford.

[MacGrew, 1999] MacGrew, J. (1999). *Focus on Grammar Basic*. Editorial Oxford.

[Soars and John, 2002d] Soars, L. and John (2002d). *American Headway N 2 Student Book*. Editorial Oxford.

Sixth Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR2D3 Design Studio VI (Mandatory)

1. General information

- **Semester**: 6th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2D2 Design Studio V (5th Sem-Pg. 136)

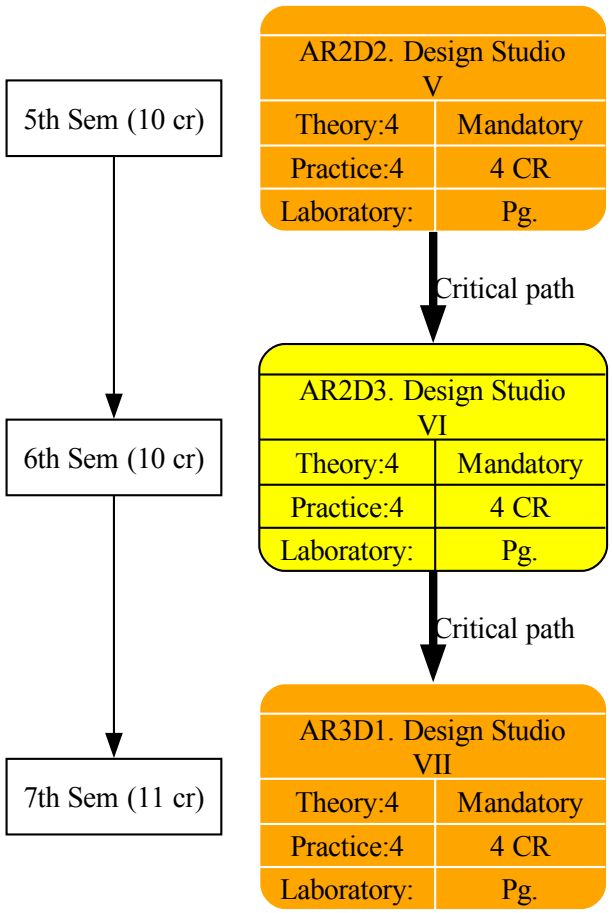


Figure 3.32: Connection Map. AR2D3 Design Studio VI

2. Course Rationale

Design Studio VI: Mixed-Use Building raises the program and scale complexity introduced in Design Studio V (AR2D2, prerequisite) to a taller, mixed-use building that stacks residential, commercial, and/or civic uses and requires explicit coordination with building systems (structural, envelope, and MEP). Students design a building whose viability depends as much on development feasibility as on

architectural resolution, and practice the project-management skills needed to carry a complex proposal from concept through a coordinated construction-ready design. This course is the foundation for the Urban Design Studio sequence that begins with Design Studio VII (AR3D1).

3. Goals of the Course

- Design the programming and spatial organization of a mixed-use building at a scale and complexity greater than any single-use project in the sequence so far.
- Coordinate the structural, envelope, and building-system assemblies of a taller building within realistic floor-to-floor height constraints.
- Select an appropriate seismic lateral-force-resisting system and detail the ductility measures required for a mixed-use building of increased height.
- Evaluate the development feasibility of the proposed building – market, site, regulatory, and financial constraints – as part of the design process.
- Apply project-management principles (scope, schedule, budget) to the development of a complex design proposal.

4. General Competences (*Outcomes*)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Usage)

AG-A09) Creates architectural designs that satisfy aesthetic and technical requirements. (Usage)

AG-A12) Possesses the design skills needed to satisfy building users' requirements within cost constraints and building regulations. (Usage)

5. Content

5.1 Large-Scale and Complex Buildings, 12 hr(s)

Competences: AG-A09

Topics: **I:** Programming and spatial organization at large scale: stacking diagrams, core-to-perimeter ratios, vertical circulation strategies, **II:** Life safety and means of egress in large buildings: occupancy-based egress design, pressurized stairwells, refuge floors, fire compartmentalization, and NFPA/IBC requirements **III:** Vertical transportation systems: elevator group design, sky lobbies, express/local zone strategies, escalators, and integration of vertical transport into building form **IV:** Hybrid and mixed-use building design: separating and linking residential, commercial, hotel, and civic programs; transfer floors, podium strategies, and shared amenity programming **V:** Phased construction and building complexity: designing for construction staging, operational continuity, future expansion, and changeable use within long-lifespan complex buildings **VI:** Campus and master plan design at large scale: site organization, wayfinding, public realm, phasing, infrastructure coordination, and identity across a multi-building ensemble

Learning Outcomes I: Identify the key design challenges - program complexity, life safety, vertical transport, and phasing - that distinguish large-scale buildings from smaller architectural projects [Familiarity] **II:** Apply large-scale building design strategies to develop a spatial and programmatic organization for a complex multi-story or mixed-use building typology [Usage] **III:** Evaluate a large-scale building design for programmatic coherence, life safety compliance, and operational efficiency [Assessment]

Bibliography: [Schierle, 2012]

5.2 Building Systems and Assemblies, 10 hr(s)

Competences: AG-A09

Topics: **I:** Integration of building systems: coordinating structural frame, mechanical/electrical/plumbing (MEP), envelope, and interior fit-out within constrained floor-to-floor heights **II:** Construction documentation for assemblies: details at 1:5, 1:10, and 1:20; section-through-wall details, sill and head conditions, and coordination between architectural **III:** Construction tolerances and coordination: dimensional tolerances in concrete, steel, and masonry; clearances for MEP rough-in **IV:** Waterproofing and moisture management: below-grade waterproofing systems, drainage planes, vapor barriers, and flashing at penetrations **V:** Fire-rated assemblies: UL-listed wall, floor, and ceiling assemblies; fire-stopping at penetrations, intumescent seals, and the architectural detailing required by fire codes **VI:** Prefabricated and modular assemblies: volumetric modular construction, panelized wall systems, and the design implications of off-site manufacturing tolerances

Learning Outcomes **I:** Identify the principal building systems and describe how they are integrated and coordinated within a multi-story building assembly [Familiarity] **II:** Develop construction-level details for a building assembly that correctly coordinate structural, envelope, and MEP systems within realistic tolerances and code requirements [Usage] **III:** Evaluate a set of construction documents for assembly coordination quality, identifying conflicts, missing details, and buildability risks [Assessment]

Bibliography: [Allen and Iano, 2019]

5.3 Seismic Design for Architecture, 10 hr(s)

Competences: AG-A09

Topics: **I:** Seismic hazards and site effects: fault rupture, ground shaking, liquefaction, landslide; site class effects on ground motion amplification **II:** Lateral force-resisting systems for seismic resistance: moment frames, braced frames (concentric, eccentric), shear walls (reinforced concrete, wood), and dual systems **III:** Ductility and capacity design: strong-column weak-beam, plastic hinge formation, confinement reinforcement in concrete columns, **IV:** Architectural integration of seismic systems: drift limits for cladding and partitions, seismic joints, diaphragm continuity, **V:** Base isolation and energy dissipation: elastomeric and sliding bearings, tuned mass dampers, viscous dampers, and their impact on architectural detailing **VI:** Performance-based seismic design (PBSD): performance objectives (immediate occupancy, life safety, collapse prevention), nonlinear static pushover analysis,

Learning Outcomes **I:** Describe the primary seismic force-resisting systems and explain how building codes classify seismic risk and prescribe detailing for ductile behavior [Familiarity] **II:** Apply seismic design principles to the early-stage design of a building, selecting an appropriate lateral system and configuring plan [Usage] **III:** Evaluate an architectural design for seismic vulnerability, identifying plan irregularities (re-entrant corners, diaphragm discontinuities) [Assessment]

Bibliography: [Schierle, 2012]

5.4 Development Process and Feasibility, 10 hr(s)

Competences: AG-A12

Topics: **I:** Development phases: site identification, option agreement, due diligence, entitlement (zoning, permits), design **II:** Due diligence for development sites: title review, environmental assessment (Phase I and II), geotechnical investigation, zoning analysis, utility availability, **III:** Entitlements and permitting: land use approvals (rezoning, variances, conditional use permits), building permits, impact fees (school, traffic, parks) **IV:** Feasibility study components: market support, site suitability, regulatory pathway, construction feasibility, financial pro forma (with sensitivity analysis), **V:** Real estate pro forma basics: projected net operating income (NOI = gross potential rent minus vacancy allowance minus operating expenses), debt service coverage ratio (DSCR),

Learning Outcomes I: Describe the major stages of the real estate development process - predevelopment, construction, lease-up, disposition - and the due diligence [Familiarity] **II:** Prepare a feasibility study for a proposed development, including market analysis, site due diligence summary, entitlement pathway, construction cost estimate, [Usage] **III:** Evaluate a development pro forma for financial viability, identifying understated risk (vacancy, construction contingency) [Assessment]

Bibliography: [Miles et al., 2007]

5.5 Project Management and Construction Economics, 8 hr(s)

Competences: AG-A05

Topics: I: Project management phases: initiation, planning, execution, monitoring/controlling, close-out; work breakdown structure (WBS), Gantt charts, critical path method (CPM), **II:** Cost estimation methods: order-of-magnitude, schematic, design development, and construction document estimates **III:** Value engineering (VE) in architecture: function analysis, cost-performance trade-offs, life cycle costing **IV:** Risk management for architectural projects: identifying design risks (code compliance, constructability), professional liability risks (errors and omissions), **V:** Construction specifications: MasterFormat divisions (CSI), section organization (part 1: general, part 2: products, part 3: execution) **VI:** Construction quality management: quality plans and inspection/test plans (ITPs) aligned with ISO 9001, non-conformance reports (NCRs) and corrective actions, and compilation of the quality dossier (material certifications, test reports, inspection records, as-built verification) for project close-out

Learning Outcomes I: Describe the key project management activities for an architectural project: scheduling, cost estimating, value engineering, risk management, and quality management, [Familiarity] **II:** Prepare a project schedule (Gantt chart) for a design project, linking deliverables to phases, and produce a schematic-level cost estimate using assembly-based unit costs [Usage] **III:** Evaluate a project's budget and schedule performance against the baseline, using earned value management (EVM) metrics to identify cost or schedule overruns [Assessment]

Bibliography: [Hendrickson, 1998]

6. Bibliography

[Allen and Iano, 2019] Allen, E. and Iano, J. (2019). *Fundamentals of Building Construction: Materials and Methods*. Wiley, 7th edition.

[Hendrickson, 1998] Hendrickson, C. (1998). *Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders*. Prentice Hall, 2nd edition.

[Miles et al., 2007] Miles, M. E., Berens, G., and Weiss, M. A. (2007). *Real Estate Development: Principles and Process*. Urban Land Institute, 4th edition.

[Schierle, 2012] Schierle, G. G. (2012). *Architectural Structures*. University of Southern California.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3B1 Structural and MEP Coordination (Mandatory)

1. General information

- **Semester**: 6th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2B3 BIM Scheduling and Cost (5th Sem-Pg. 133)

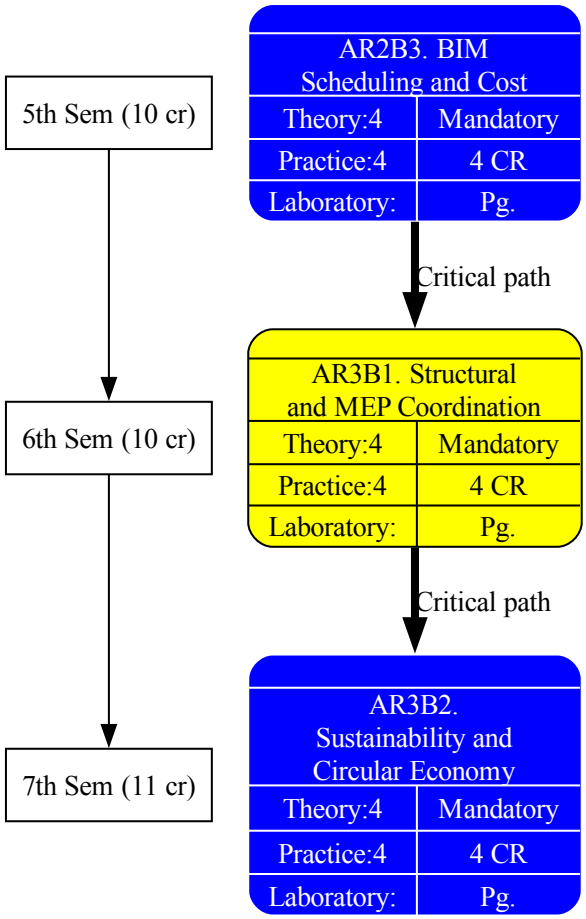


Figure 3.33: Connection Map. AR3B1 Structural and MEP Coordination

2. Course Rationale

Structural and MEP Coordination is the sixth course of the ten-course BIM I-X sequence (AR1B1 to AR4B1), following BIM Scheduling and Cost (AR2B3, prerequisite). Having established scheduling, cost, and lean-construction habits on the federated model, students now turn the coordination skills built earlier in the sequence (Multidisciplinary Coordination, AR2B1) toward the structural and MEP disciplines specifically: exchanging models with structural analysis and MEP routing software, resolving the spatial conflicts that generate RFIs on real projects, and developing those coordinated

models to fabrication-level detail (LOD 400) for shop drawings and prefabrication. The course also introduces systematic model quality control – auditing and parameter validation – as the discipline that makes every later coordination and federation step on the sequence's models trustworthy. As in every course of the sequence, the transversal Practicum unit gives students graded, guided exercises in the structural/MEP and fabrication-detailing software this course's theme requires, preparing them for the course that follows, Sustainability and Circular Economy (AR3B2).

3. Goals of the Course

- Coordinate a federated BIM model's structural and MEP elements, identifying and resolving spatial conflicts between systems using IFC/CIS2 data exchange.
- Develop structural connection and MEP routing details to fabrication-level (LOD 400), producing shop-drawing-ready models for steel, precast, and prefabricated MEP assemblies.
- Run systematic model-auditing and parameter-validation routines on a BIM model, correcting naming, data, and modeling-quality issues before it is shared or federated.
- Build hands-on proficiency in the course's structural/MEP coordination and fabrication-detailing software through a sequence of guided, graded practicum exercises culminating in a cumulative deliverable.

4. General Competences (*Outcomes*)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)

AG-A14) Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture. (Usage)

5. Content

5.1 BIM for Structural and MEP Coordination, 24 hr(s)

Competences: AG-A08

Topics: **I:** BIM-based structural workflows: structural analysis model from architectural BIM (Revit, Tekla), data exchange via IFC or CIS/2 **II:** MEP systems coordination in BIM: routing and clash-avoidance for HVAC ducts, plumbing, and electrical conduit within a federated model; spatial coordination with structural and architectural elements

Learning Outcomes **I:** Describe the BIM-based workflow for exchanging a model between architectural, structural, and MEP software, and explain the role of IFC/CIS2 in that exchange [Familiarity] **II:** Coordinate a federated model's structural and MEP elements, identifying and resolving spatial conflicts between systems [Usage] **III:** Evaluate a structural/MEP-coordinated BIM model for spatial conflicts, data-exchange integrity, and coordination completeness [Assessment]

Bibliography: [Sacks et al., 2018]

5.2 Fabrication-Level BIM Detailing, 24 hr(s)

Competences: AG-A14

Topics: **I:** Structural fabrication detailing: connection design, rebar detailing, and steel/precast shop-drawing-level modeling (Tekla, Advance Steel) **II:** MEP fabrication modeling: spool drawings for ductwork and piping, prefabrication-ready routing, and hanger/support detailing at LOD 400 **III:** Coordinating fabrication-level models with offsite prefabrication schedules and delivery logistics

Learning Outcomes **I:** Describe the difference between a construction-level (LOD 350) and a fabrication-level (LOD 400) structural or MEP model, and identify the detailing each requires [Familiarity] **II:** Develop a structural connection or MEP routing detail to fabrication-level (LOD 400), ready for shop-drawing production [Usage] **III:** Evaluate a fabrication-level BIM model for the completeness and buildability of its connection and routing details [Assessment]

Bibliography: [Kolarevic, 2003]

5.3 BIM Model Quality Control and Auditing, 24 hr(s)

Competences: AG-A06

Topics: **I:** Model auditing tools and routines: automated checks for unnamed/duplicate elements, orphaned families, and file size/performance issues **II:** Parameter and naming-convention validation: checking that model elements carry the required parameters and follow the project's naming standards before federation **III:** Automated rule-checking scripts (Dynamo, Solibri rulesets) for enforcing modeling standards across a large or multi-author model

Learning Outcomes **I:** Describe the kinds of modeling and data errors a BIM quality-control audit is designed to catch, and why they matter before model federation [Familiarity] **II:** Run a model audit on a BIM file, identifying and correcting naming, parameter, and modeling-quality issues before sharing it with the project team [Usage] **III:** Evaluate a model's audit report to judge whether it is ready for federation and coordination, or requires further cleanup [Assessment]

Bibliography: [Kensek, 2014]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: **I:** Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes **I:** Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Wing, 2012]

6. Bibliography

[Kensek, 2014] Kensek, K. M. (2014). *Building Information Modeling*. Routledge, 1st edition.

[Kolarevic, 2003] Kolarevic, B. (2003). *Architecture in the Digital Age: Design and Manufacturing*. Spon Press, 1st edition.

[Sacks et al., 2018] Sacks, R., Eastman, C., Lee, G., and Teicholz, P. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*. Wiley, 3rd edition.

[Wing, 2012] Wing, E. (2012). *Autodesk Revit MEP: No Experience Required*. Sybex, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

ID203 Technical and professional English V (Mandatory)

1. General information

- **Semester**: 6th Sem. **Credits**: 2
- **Hour of this course**: **Theory**: 1 hours; **Practice**: 2 hours;
- **Prerrequisites**:
  - ID202 Technical and professional English IV (5th Sem-Pg. 141)

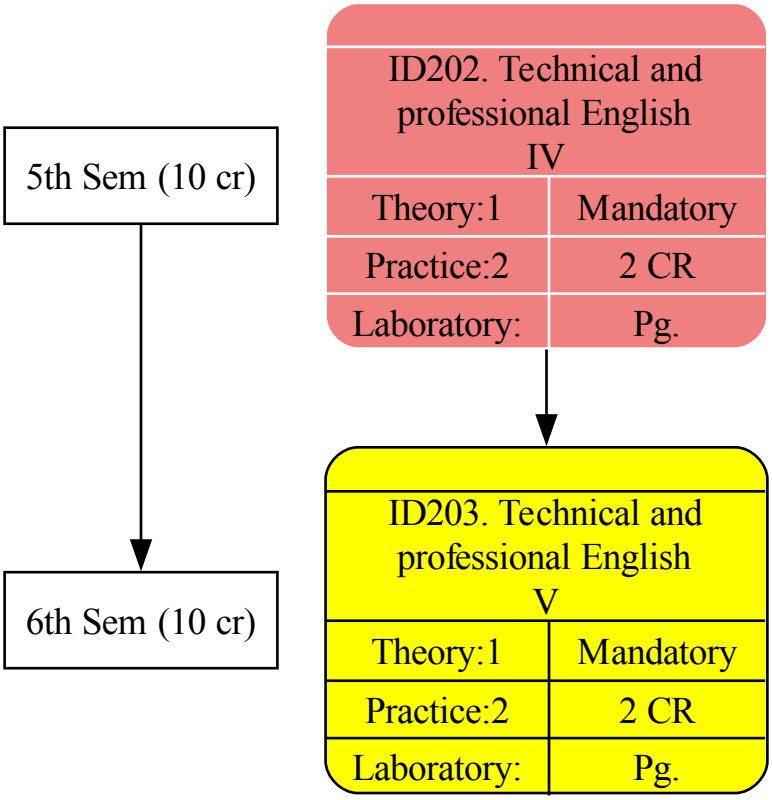


Figure 3.34: Connection Map. ID203 Technical and professional English V

2. Course Rationale

A fundamental part of the integral formation of a professional is the ability to communicate in a foreign language in addition to the native language itself. In the engineering and computing career, technical English is the most critical tool for accessing the forefront of knowledge and research, writing scientific papers, participating in international conferences, and collaborating in global teams. This course brings students to the level of autonomous technical communicators capable of producing and critically evaluating academic and professional content.

3. Goals of the Course

- Increase the ability and fluency to communicate complex technical ideas in English.

- Ensure that students interact with emphasis on scientific argumentation and advanced technical writing.
- Master vocabulary for software engineering, data science, and systems research.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Usage)

5. Content

5.1 Scientific Argumentation, 12 hr(s)

Competences: AG-A04

Topics: I: Advanced review of auxiliary verbs and verb tenses in academic writing. **II:** Negative questions and emphatic answers in scientific debate. **III:** Word formation: Prefixes and suffixes common in computing and science. **IV:** Correcting misconceptions: Refuting claims in technical discussions.

Learning Outcomes I: By the end of the unit, students use auxiliaries and tenses precisely to construct scientific arguments, challenge erroneous technical claims, and engage in structured academic debate.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.2 Research Methodology, 12 hr(s)

Competences: AG-A04

Topics: I: Present Simple vs. Present Continuous: Distinguishing general facts from ongoing experiments. **II:** State verbs and action verbs in experimental descriptions. **III:** Vocabulary: Research design, experimental variables, data collection methods. **IV:** Writing: Description of a research method or experimental procedure.

Learning Outcomes I: Students differentiate between stative and progressive uses to accurately describe scientific laws, ongoing experiments, and research methodologies in computing and engineering.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.3 Case Studies, 12 hr(s)

Competences: AG-A04

Topics: I: Narrative tenses: Simple Past, Past Continuous, and Past Perfect in case study analysis. **II:** Structure of "Used to" and "Would" for describing legacy systems and past practices. **III:** Vocabulary: Historical computing cases, paradigm shifts, engineering lessons learned. **IV:** Writing: Structured case study report on a computing incident or innovation.

Learning Outcomes I: Students analyze and narrate sequences of technical events and historical computing cases fluently, applying narrative tenses correctly in professional case study reports.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.4 Research Proposals, 12 hr(s)

Competences: AG-A04

Topics: I: Predictions and plans: Future tense review for academic proposal writing. **II:** Future Continuous and Future Perfect in project scope and outcomes. **III:** Vocabulary: Research objectives, expected contributions, scope and limitations. **IV:** Writing: Short research proposal or technical project abstract.

Learning Outcomes I: Students project research goals and anticipated outcomes, and make evidence-based predictions about the evolution of technology using appropriate future forms in formal academic writing.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.5 Technical Documentation, 12 hr(s)

Competences: AG-A04

Topics: I: Verb patterns (Verbs followed by -ing or infinitive) in instructional writing. **II:** Expressions with "Like" for analogies and technical comparisons. **III:** Vocabulary: API documentation, user manuals, technical specifications. **IV:** Debates: Standards for open-source documentation and reproducibility.

Learning Outcomes I: Students use complex verb patterns to write clear, precise technical documentation and use analogical reasoning to explain technical concepts to diverse audiences.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.6 Long-term Projects, 12 hr(s)

Competences: AG-A04

Topics: I: Present Perfect Continuous vs. Simple Present Perfect in research progress reports. **II:** Modal verbs of deduction (Present and Past) for interpreting experimental results. **III:** Vocabulary: Long-running systems, sustained research programs, startup development. **IV:** Oral presentations: "Progress report on a computing research project".

Learning Outcomes I: Students discuss long-term research and development activities, make deductions about technical outcomes, and present progress reports on computing projects with appropriate academic register.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.7 Advanced Technical Writing, 12 hr(s)

Competences: AG-A04

Topics: I: Relative clauses (Defining vs. Non-defining) in technical paper writing. **II:** Advanced passive voice in formal scientific and engineering prose. **III:** Vocabulary: Peer review, impact factors, citation practices, open access. **IV:** Writing: Abstract and introduction section of a computing research paper.

Learning Outcomes I: Students write precise, well-structured technical and scientific texts using relative clauses and advanced passive constructions to add depth and clarity to research writing.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

5.8 English for Software Engineering, 12 hr(s)

Competences: AG-A04

Topics: I: Agile Methodologies: Scrum, Kanban, and XP terminology in English. **II:** QA (Quality Assurance) and Testing: Test plans, bug reports, acceptance criteria. **III:** Software requirements documentation: user stories, use cases, specifications. **IV:** Simulation: Technical team meeting (Sprint planning and retrospective).

Learning Outcomes I: By the end of the course, students command software engineering and project management terminology, can produce professional technical documents, and actively participate in international technical meetings and reviews in English.

Bibliography: [Soars and John, 2002g, Soars and John, 2002i, Soars and John, 2002h, Cambridge, 2006, MacGrew, 1999]

6. Bibliography

[Cambridge, 2006] Cambridge (2006). *Diccionario Inglés-Espanol Cambridge*. Editorial Oxford.

[MacGrew, 1999] MacGrew, J. (1999). *Focus on Grammar Basic*. Editorial Oxford.

[Soars and John, 2002g] Soars, L. and John (2002g). *American Headway N 3 Student Book*. Editorial Oxford.

[Soars and John, 2002h] Soars, L. and John (2002h). *American Headway N 3 Teachers Book*. Editorial Oxford.

[Soars and John, 2002i] Soars, L. and John (2002i). *American Headway N 3 Work Book*. Editorial Oxford.

Seventh Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3B2 Sustainability and Circular Economy (Mandatory)

1. General information

- **Semester**: 7th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3B1 Structural and MEP Coordination (6th Sem-Pg. 149)

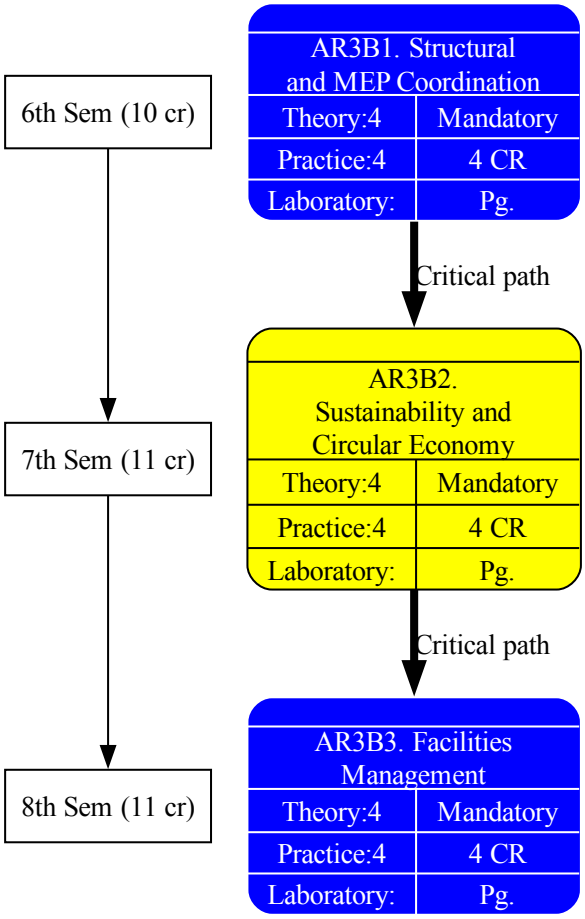


Figure 3.35: Connection Map. AR3B2 Sustainability and Circular Economy

2. Course Rationale

Sustainability and Circular Economy is the seventh course of the ten-course BIM I-X sequence (AR1B1 to AR4B1) that runs obligatorily alongside the Design Studio and Representation lines across the whole program. Building on Structural and MEP Coordination (AR3B1, prerequisite), where students consolidated model-based coordination and delivery practice, this course turns the BIM

model into the data source for a building's environmental performance: exporting model geometry and materials to energy and daylight analysis tools, tagging model elements for circular-economy strategies such as design-for-disassembly and material passports, and tracking a project's compliance with green-building certification systems (LEED, EDGE, BREEAM) directly from model data and generating the corresponding documentation. The course's transversal Practicum unit – a hands-on software-lab component that recurs, unchanged in structure, across all ten courses of the sequence – shifts its guided exercises and certification-aligned practice to the sustainability-analysis and certification-tracking tools relevant to this course's theme.

3. Goals of the Course

- Export a BIM model's geometry and material data to run energy and daylight analyses, and use the results to inform design iterations.
- Tag a BIM model's elements with material-passport and design-for-disassembly data to support a future deconstruction or reuse scenario.
- Track a chosen set of green-building certification credits (LEED, EDGE, or BREEAM) against a BIM model's quantities and analysis results, and generate the supporting compliance documentation.
- Build hands-on proficiency in the course's BIM sustainability-analysis and certification-tracking tools through a sequence of guided, graded practicum exercises culminating in a cumulative deliverable.

4. General Competences (*Outcomes*)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A12) Possesses the design skills needed to satisfy building users' requirements within cost constraints and building regulations. (Usage)

AG-A13) Demonstrates knowledge of the means to achieve ecologically responsible design and environmental conservation and rehabilitation. (Usage)

5. Content

5.1 BIM for Sustainability Analysis, 24 hr(s)

Competences: AG-A13

Topics: I: BIM-integrated energy analysis: gbXML export from BIM authoring tools to energy-simulation engines, and iterative design-stage energy performance feedback **II:** BIM-integrated daylight and solar analysis: linking BIM massing and material data to daylight simulation (Insight, IES-VE) and solar-access studies **III:** Embedding sustainability data in BIM objects: embodied-carbon data (EPDs) and material-passport information attached to BIM elements for lifecycle assessment

Learning Outcomes I: Describe how BIM models can be exported or linked to energy, daylight, and sustainability-analysis tools, and explain the data requirements for each [Familiarity] **II:** Export a BIM model's geometry and material data to run an energy or daylight analysis, and use the results to inform a design iteration [Usage] **III:** Evaluate a BIM-based sustainability analysis for data accuracy and the appropriateness of its design recommendations [Assessment]

Bibliography: [de Wilde, 2018]

5.2 BIM for Circular Economy and Material Reuse, 24 hr(s)

Competences: AG-A13

Topics: **I:** Design-for-disassembly principles embedded in BIM: reversible connections, material separation, and modeling components for future deconstruction **II:** Material passports and material banks: tagging BIM elements with reuse potential, provenance, and end-of-life data for future material recovery **III:** Deconstruction sequencing and planning using a BIM model, mirroring 4D construction scheduling in reverse

Learning Outcomes **I:** Describe how BIM data (material passports, reversible-connection tagging) can support circular-economy design decisions [Familiarity] **II:** Tag a BIM model's elements with material-passport and design-for-disassembly data to support a future deconstruction or reuse scenario [Usage] **III:** Evaluate a BIM-based circular-economy strategy for a project, judging the completeness of its material-passport data and the feasibility of its deconstruction plan [Assessment]

Bibliography: [Addis, 2006]

5.3 BIM-Supported Green Building Certification, 24 hr(s)

Competences: AG-A12

Topics: **I:** Certification credit tracking from model data: linking BIM quantities and performance analysis results to LEED, EDGE, or BREEAM credit requirements **II:** Generating certification documentation (narratives, calculations, drawings) directly from BIM model data and schedules

Learning Outcomes **I:** Describe how BIM model data can be linked to green-building certification credit requirements and documentation [Familiarity] **II:** Track a chosen set of green-building certification credits against a BIM model's quantities and analysis results [Usage] **III:** Evaluate a BIM-based certification compliance package for completeness and consistency with the model it was generated from [Assessment]

Bibliography: [U.S. Green Building Council, 2013]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: **I:** Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes **I:** Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Krygiel and Nies, 2008]

6. Bibliography

[Addis, 2006] Addis, B. (2006). *Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling*. Earthscan, 1st edition.

[de Wilde, 2018] de Wilde, P. (2018). *Building Performance Analysis*. Wiley, 1st edition.

[Krygiel and Nies, 2008] Krygiel, E. and Nies, B. (2008). *Green BIM: Successful Sustainable Design with Building Information Modeling*. Sybex, 1st edition.

[U.S. Green Building Council, 2013] U.S. Green Building Council (2013). *LEED v4 Reference Guide for Building Design and Construction*. USGBC, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3D1 Design Studio VII (Mandatory)

1. General information

- **Semester**: 7th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR2D3 Design Studio VI (6th Sem-Pg. 145)

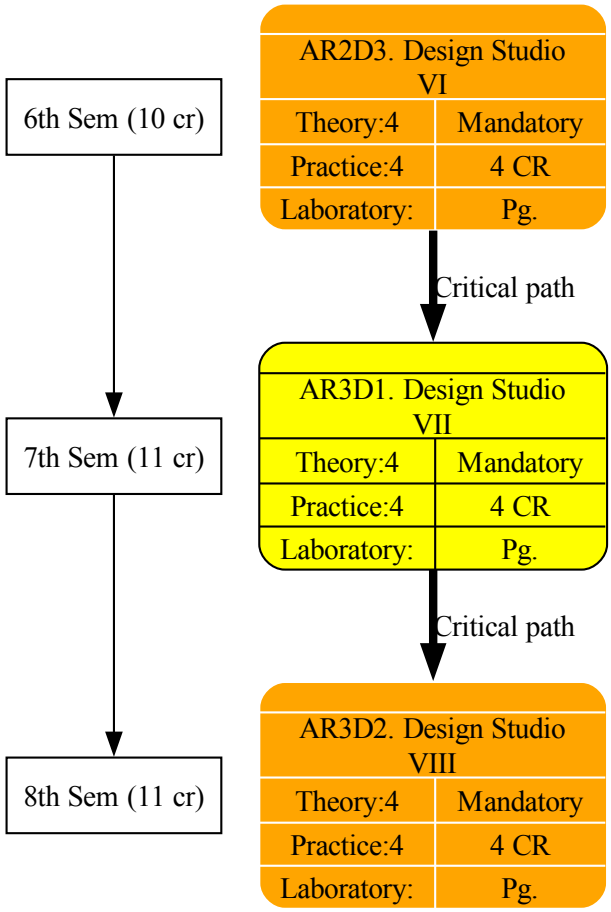


Figure 3.36: Connection Map. AR3D1 Design Studio VII

2. Course Rationale

Urban Design Studio VII: Public Space and Landscape shifts the sequence's scale of operation from the single building, the focus of Design Studio VI (AR2D3, prerequisite), to the city: streets, blocks, public space, and the urban tissue that frames every building the students have designed so far. Students analyze the morphology of an existing urban fabric and the planning frameworks (zoning, master-planning, contemporary urban theory) that shape it, then propose an urban design and landscape intervention at the scale of a public space, a street, or a neighborhood. The course is the

foundation for Design Studio VIII (AR3D2), the first of the two more specialized, higher-complexity studios that close the sequence.

3. Goals of the Course

- Analyze the morphology of an existing urban fabric – streets, blocks, plots, and urban typologies – as the basis for an urban design proposal.
- Apply contemporary planning methods and urban theory (zoning, master vs. strategic planning, public participation) to a real urban design problem.
- Design public open space and landscape – parks, plazas, streets – integrating ecological, social, and cultural functions.
- Apply landscape design principles (site analysis, spatial organization, circulation) and the integration of landscape with urban green infrastructure.
- Design across urban design scales – from the regional structure down to the block and the street – applying the design guidelines appropriate to each.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Usage)

AG-A13) Demonstrates knowledge of the means to achieve ecologically responsible design and environmental conservation and rehabilitation. (Usage)

AG-A15) Understands the relationship between people, buildings, and their environment, and the need to relate buildings and spaces to human scale and needs. (Usage)

5. Content

5.1 Urban Form and Morphology, 8 hr(s)

Competences: AG-A01

Topics: **I:** Kevin Lynch's city image elements: paths, edges, districts, nodes, and landmarks; their role in legibility and wayfinding; application to urban design analysis and intervention **II:** Street, block, and plot systems: typologies (grid, radial, organic, cul-de-sac), block dimensions and permeability, plot subdivision, **III:** Urban building typologies: single-family detached, row house (townhouse), courtyard building, slab, point tower, and linear block **IV:** Morphological analysis methods: Conzenian (burgage cycle, fringe belts), space syntax (integration, connectivity, choice), and figure-ground diagrams for reading urban form **V:** Urban fabric layers: plot subdivision history, street network evolution, land use succession, and the persistence of plot boundaries over centuries as a design constraint

Learning Outcomes **I:** Identify the key morphological elements of a city - streets, blocks, plots, buildings - and describe the relationships among them that define urban character [Familiarity] **II:** Apply morphological analysis tools (figure-ground, space syntax) to an urban sector, identifying its legibility, connectivity, and typological diversity [Usage] **III:** Evaluate the morphological coherence and permeability of a proposed urban design, comparing block sizes, street connectivity, [Assessment]

Bibliography: [Kropf, 2017]

5.2 Contemporary Planning Methods and Theory, 10 hr(s)

Competences: AG-A01

Topics: **I:** Planning methods: zoning (Euclidean, form-based, performance-based), master planning vs. strategic planning, public participation (charrettes, community workshops **II:** Smart growth and new urbanism: principles (transit-oriented development, walkability, mixed-income housing, urban growth boundaries), Andrés Duany's transect, **III:** Contemporary urban theory:

Lefebvre's production of space, Harvey's right to the city, Sennett's open city, and the role of informality, participation, **IV:** Integration of civil engineering technical constraints (structural, geotechnical, utility infrastructure, and transportation) into urban planning and architectural design frameworks; the collaborative role of civil engineers in multidisciplinary building and urban project teams

Learning Outcomes I: Apply a planning method - such as form-based coding or scenario planning - to a specific urban site, producing land use or built form regulations that align with stated policy [Usage] **II:** Evaluate a current urban plan or zoning code against contemporary planning principles (walkability, mixed-use, transit orientation, social equity), identifying strengths [Assessment]

Bibliography: [Jacobs, 1961, Gehl, 2010]

5.3 Urban Design at Multiple Scales, 10 hr(s)

Competences: AG-A15

Topics: I: Regional and city scale: transit corridors, green belts, growth boundaries, satellite towns, and the relationship between density **II:** Neighborhood scale: walkability (5-10 minute walking radius), mixed-use zoning, social infrastructure (schools, clinics, community centers), and the 20-minute neighborhood concept **III:** Block and street scale: block length for pedestrian permeability (80-120 m max), street section design (lane widths, sidewalks, bike lanes, street trees, furniture zone), **IV:** Public space design: squares, plazas, parks, pocket parks, and streets as public space; William Whyte's elements of successful public space (sittable space, sun, food **V:** Urban design guidelines: building setbacks, height limits, architectural character, facade articulation, signage, lighting,

Learning Outcomes I: Describe the key design considerations at each urban scale - regional, neighborhood, block, street, and public space - [Familiarity] **II:** Develop a set of urban design guidelines for a specific neighborhood or street typology, integrating density, building height, block length, street section, [Usage] **III:** Evaluate an urban design project for its multi-scale coherence, assessing how well it integrates regional transit, neighborhood walkability, block permeability, street safety, [Assessment]

Bibliography: [Lynch, 1960]

5.4 Landscape and Open Space Design, 8 hr(s)

Competences: AG-A13

Topics: I: Park types and their urban roles: pocket parks, neighborhood parks, district parks, regional parks, linear parks (greenways), waterfront parks, and national urban parks **II:** Green infrastructure in urban design: bioswales, rain gardens, permeable pavements, urban forests, and green roofs **III:** Placemaking for public space: Project for Public Spaces criteria (sociability, uses/activities, access, comfort/image) **IV:** Integration of landscape and urban form: view corridors, public space networks, park-to-park connections, and the role of open space in structuring urban density and walkability **V:** Equity in open space access: distributional equity (distance, size per capita), quality equity (facilities, safety, maintenance),

Learning Outcomes I: Describe the typologies of urban open space and their appropriate spatial distribution, programming, and ecological functions [Familiarity] **II:** Design a public open space (plaza, park, or greenway) that integrates stormwater management, seating, shade, and circulation into a coherent spatial composition [Usage] **III:** Evaluate a public space design using placemaking criteria (access, comfort, activities, sociability) and identify modifications to improve its use frequency and user diversity [Assessment]

Bibliography: [Booth, 1983]

5.5 Landscape Design Principles and Process, 10 hr(s)

Competences: AG-A13

Topics: **I:** Site analysis for landscape: topography (slope, aspect), soils (texture, drainage, fertility), hydrology (surface flow, groundwater, flood zones), vegetation, microclimate (sun **II:** Spatial organization in landscape design: rooms (outdoor rooms), edges (soft vs. hard), sequence (entry, discovery, culmination), focal points (gazebo, sculpture, specimen tree) **III:** Circulation in landscape: primary (vehicular, bike), secondary (pedestrian), service (maintenance), accessible routes (ADA gradients, surface firmness), **IV:** Landscape architectural drawing: site plans, grading plans, planting plans, irrigation plans, construction details (walls, paving, water features), **V:** View analysis and visual impact: key views (from building, from approach), framed views, borrowed views, screening of undesirable views, and the use of massing

Learning Outcomes **I:** Describe the elements of landscape site analysis and the spatial organization principles of outdoor rooms, edges, and circulation [Familiarity] **II:** Produce a landscape design concept for a small site, integrating site analysis data into a spatial layout with defined outdoor rooms, circulation, and focal points [Usage] **III:** Evaluate a landscape design for its responsiveness to site conditions (topography, hydrology, vegetation) and user needs, identifying strengths and weaknesses in circulation [Assessment]

Bibliography: [Booth, 1983]

5.6 Urban Landscape and Green Infrastructure, 8 hr(s)

Competences: AG-A13

Topics: **I:** Green infrastructure types at urban scale: green roofs (extensive, intensive, biodiverse), rain gardens, bioswales, permeable alleys, street tree trenches, constructed wetlands **II:** Urban forestry: street tree species selection (structural integrity, salt tolerance, root behavior), spacing and placement for shade **III:** Water-sensitive urban design: integrating stormwater management with landscape aesthetics, water reuse for irrigation, **IV:** Urban heat island mitigation via landscape: cool pavements (high albedo), shading from street trees and green structures, evapotranspirative cooling from green roofs **V:** Green networks and ecological corridors: connecting parks and open spaces for wildlife movement, integrating greenways along waterways,

Learning Outcomes **I:** Describe the types of green infrastructure used in urban landscapes - green roofs, rain gardens, bioswales, tree trenches - [Familiarity] **II:** Design a green infrastructure intervention for an urban site (plaza, street, rooftop) that manages a specified stormwater volume, reduces surface temperature, and provides amenity [Usage] **III:** Evaluate the performance of an existing green infrastructure installation against design goals (stormwater capture, plant survival, user acceptance) [Assessment]

Bibliography: [Gehl, 2010]

6. Bibliography

[Booth, 1983] Booth, N. K. (1983). *Basic Elements of Landscape Architectural Design*. Waveland Press.

[Gehl, 2010] Gehl, J. (2010). *Cities for People*. Island Press.

[Jacobs, 1961] Jacobs, J. (1961). *The Death and Life of Great American Cities*. Random House.

[Kropf, 2017] Kropf, K. (2017). *The Handbook of Urban Morphology*. Wiley.

[Lynch, 1960] Lynch, K. (1960). *The Image of the City*. MIT Press.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR400 Scientific Research Methodology (Mandatory)

1. General information

- **Semester**: 7th Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 3 hours;
- **Prerrequisites**: None

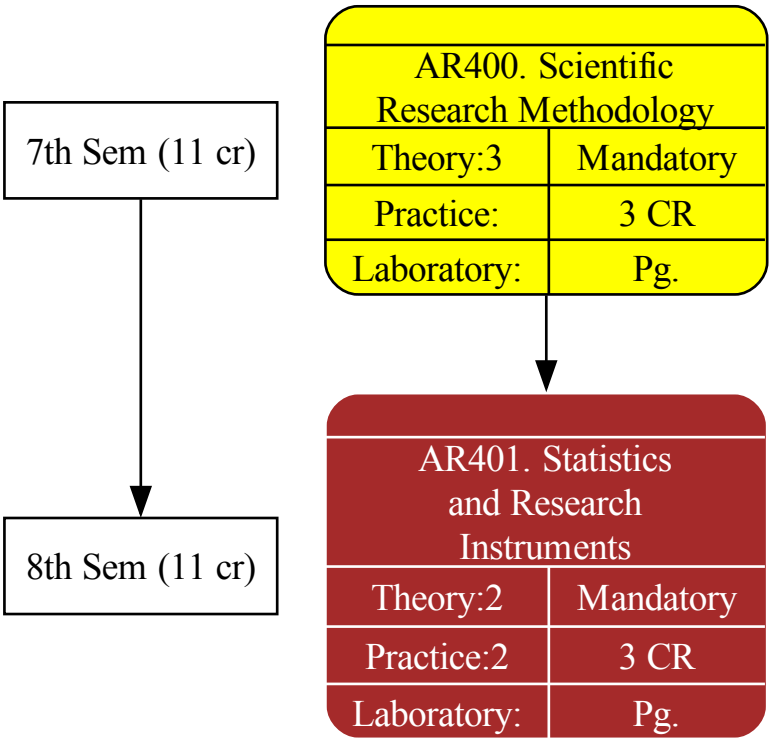


Figure 3.37: Connection Map. AR400 Scientific Research Methodology

2. Course Rationale

Scientific Research Methodology opens the research track of the specialization (Methodology – Statistics – Research Workshop – Research Work, ARC400-ARC403), giving every student the common, topic-independent toolkit – epistemology, research design, core quantitative and qualitative methods, theoretical-framework construction – before Research Workshop (ARC402) applies it to each student's own thesis topic and Statistics (ARC401) deepens the quantitative/instrument side. It differs in emphasis from the existing Architecture Research Methodology course (AR400), which focuses on evidence-based design and post-occupancy evaluation specific to buildings; this course instead targets territorial and urban-scale research problems.

3. Goals of the Course

- Compare the epistemological foundations (positivism, interpretivism, critical theory) that underlie different research traditions applied to territorial and urban problems.

- Select and justify a research design (experimental vs. non-experimental; cross-sectional vs. longitudinal) appropriate to a given territorial or urban research question.
- Apply core quantitative research methods – survey design, variable measurement – to territorial and urban problems.
- Apply core qualitative and ethnographic methods – interviews, participatory observation, documentary analysis – to territorial and urban problems.
- Build a coherent theoretical framework (state of the art, conceptual framework) that grounds a research proposal.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Assessment)

5. Content

5.1 Research Design and Methodologies, 12 hr(s)

Competences: AG-A10

Topics: **I:** Formulating research questions in architecture: descriptive, relational, causal; turning design problems into researchable questions **II:** Choosing a research methodology: quantitative (hypothesis testing, statistical), qualitative (interpretive, case study), mixed methods, **III:** Validity and reliability in architectural research: internal validity, external validity (generalizability), construct validity, **IV:** Research ethics in architectural research: informed consent, privacy (anonymization of building users), institutional review board (IRB) protocols, **V:** Mixed methods research: sequential (qualitative then quantitative) and concurrent designs; integrating qualitative findings (user interviews) with quantitative data (occupancy

Learning Outcomes **I:** Describe the main research methodologies in architecture - quantitative, qualitative, mixed methods, practice-based - and explain their appropriate applications [Familiarity] **II:** Develop a research design for an architectural inquiry, including research question, literature review, methodology selection, data collection protocol, and analysis plan [Usage] **III:** Evaluate the research design of a published architectural study for validity, reliability, and ethical soundness, identifying methodological strengths and weaknesses [Assessment]

Bibliography: [Creswell and Creswell, 2018, Groat and Wang, 2013]

5.2 Theoretical Framework and Literature Review, 12 hr(s)

Competences: AG-A04

Topics: **I:** Systematic search of scientific and technical literature: specialized databases (Scopus, Web of Science, ASCE Library), keywords, and Boolean operators **II:** Critical reading and synthesis of scientific articles, technical standards, and prior research reports **III:** Building the conceptual and theoretical framework: defining key concepts, relationships between variables, and reference theoretical models **IV:** Identifying knowledge gaps (research gap) and justifying the originality of the proposed contribution **V:** Bibliographic reference management and citation styles (APA, IEEE) using tools such as Zotero or Mendeley

Learning Outcomes **I:** Explain the structure and purpose of a theoretical framework within a civil engineering research project [Familiarity] **II:** Conduct a systematic search of scientific and technical literature on a chosen research topic using specialized databases [Usage] **III:** Synthesize the state of the art of a research topic into a coherent theoretical framework that identifies a knowledge gap [Assessment]

Bibliography: [Creswell and Creswell, 2018, Groat and Wang, 2013]

5.3 Quantitative Methods in Architectural Research, 12 hr(s)

Competences: AG-A10

Topics: **I:** Survey design for architectural research: sampling methods (probability, convenience), questionnaire design (Likert scales, semantic differential), response rate optimization, **II:** Experimental designs: true experiments (random assignment, control group), quasi-experiments (non-randomized, pre-post, time series), **III:** Descriptive statistics: measures of central tendency (mean, median, mode), dispersion (standard deviation, range, interquartile range), **IV:** Inferential statistics: hypothesis testing (t-test, ANOVA, chi-square), correlation and regression (linear, multiple), and interpretation of p-values **V:** Instrumentation for quantitative data collection: environmental sensors (temperature, light, CO_2), occupancy counters, objective performance measures (task completion time

Learning Outcomes **I:** Describe the main quantitative methods in architectural research - surveys, experiments, quasi-experiments - [Familiarity] **II:** Design a survey or experiment to test a hypothesis about the effect of a design variable (lighting, color, layout) on user satisfaction, task performance, or behavior [Usage] **III:** Evaluate a quantitative architectural study for sampling validity, statistical analysis appropriateness, and correct interpretation of p-values and effect sizes [Assessment]

Bibliography: [Creswell and Creswell, 2018, Salkind, 2017]

5.4 Qualitative and Ethnographic Methods, 12 hr(s)

Competences: AG-A10

Topics: **I:** Interviews and focus groups: structured vs. semi-structured vs. unstructured interviews, focus group dynamics, questioning strategies (probing, laddering), and recording **II:** Ethnography and observation in architecture: participant observation (researcher as user), non-participant observation (fly-on-the-wall), time-sampling behavior mapping, **III:** Content and thematic analysis: coding qualitative data (open coding, axial coding, selective coding), identifying themes **IV:** Grounded theory approach in architectural research: generating theory from data rather than hypothesis testing; constant comparative method **V:** Case study methodology in architecture: single vs. multiple case design, case selection (typical, extreme, revelatory), data triangulation (documents, interviews, observations)

Learning Outcomes **I:** Describe the main qualitative methods in architectural research - interviews, focus groups, ethnography, grounded theory - [Familiarity] **II:** Conduct a qualitative study (interview, observation, or focus group) to investigate how users experience a built space, and analyze the data using thematic coding [Usage] **III:** Evaluate the rigor of a qualitative architectural study based on credibility, transferability, dependability, and confirmability criteria (Lincoln & Guba) [Assessment]

Bibliography: [Creswell and Poth, 2018, Charmaz, 2014]

6. Bibliography

[Charmaz, 2014] Charmaz, K. (2014). *Constructing Grounded Theory*. SAGE Publications, 2nd edition.

[Creswell and Creswell, 2018] Creswell, J. W. and Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications, 5th edition.

[Creswell and Poth, 2018] Creswell, J. W. and Poth, C. N. (2018). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications, 4th edition.

[Groat and Wang, 2013] Groat, L. N. and Wang, D. (2013). *Architectural Research Methods*. Wiley, 2nd edition.

[Salkind, 2017] Salkind, N. J. (2017). *Statistics for People Who (Think They) Hate Statistics*. SAGE Publications, 6th edition.

Eighth Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3B3 Facilities Management (Mandatory)

1. General information

- **Semester**: 8th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3B2 Sustainability and Circular Economy (7th Sem-Pg. 156)

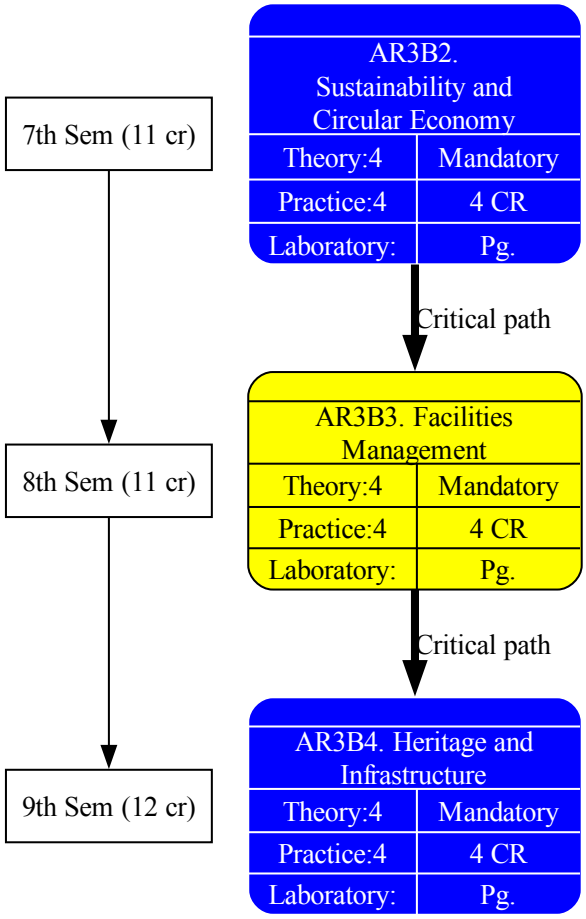


Figure 3.38: Connection Map. AR3B3 Facilities Management

2. Course Rationale

Facilities Management is the eighth course in the obligatory BIM I-X sequence, building directly on Sustainability and Circular Economy (AR3B2, prerequisite). Where the first seven courses in the sequence progressively build, coordinate, schedule, cost, and environmentally evaluate a BIM model through design and construction, this course moves the model across the handover threshold

into building operations: preparing COBie asset data and as-built models for facilities management, evolving that handover model into a live operational digital twin through IoT sensor integration and predictive-maintenance workflows, and structuring the underlying asset data with industry classification standards (Uniclass, OmniClass) and the COBie schema. A dedicated software practicum, common to every course in the sequence, grounds this theoretical content in guided, certification-aligned exercises. The course prepares students for Heritage and Infrastructure (AR3B4), which extends BIM into heritage documentation, infrastructure, and reality capture.

3. Goals of the Course

- Prepare BIM models and COBie-compliant asset data for handover from construction to a facilities-management team.
- Build and operate a facilities-management digital twin by integrating IoT sensor feeds with an as-built BIM model for condition monitoring and predictive maintenance.
- Classify building assets and structure their operational data using Uniclass/OmniClass and the COBie schema to support interoperable facilities-management handover.
- Demonstrate proficiency in facilities-management-oriented BIM software through a certification-aligned practicum.

4. General Competences (*Outcomes*)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Usage)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

5. Content

5.1 BIM for Facilities Management, 24 hr(s)

Competences: AG-A05

Topics: **I:** BIM handover and facilities management: COBie data for asset management, as-built BIM models, digital twin seeding from construction BIM

Learning Outcomes **I:** Describe the BIM-to-FM handover process, including COBie data requirements and the role of as-built models in facilities management [Familiarity] **II:** Prepare a COBie data set and as-built BIM model for handover to a facilities-management team [Usage] **III:** Evaluate a BIM-to-FM handover package for completeness and usability, identifying missing asset data or model discrepancies [Assessment]

Bibliography: [Teicholz, 2013]

5.2 Operational Digital Twins from BIM, 24 hr(s)

Competences: AG-A06

Topics: **I:** IoT sensor integration with an as-built BIM model: mapping sensor feeds (temperature, occupancy, energy use) to model elements and spaces **II:** Predictive-maintenance workflows: using live and historical operational data linked to a digital twin to anticipate equipment failure and schedule maintenance **III:** Building performance dashboards built on digital-twin data for facilities managers and building owners

Learning Outcomes **I:** Describe how an as-built BIM model becomes a live operational digital twin through sensor integration and ongoing data feeds [Familiarity] **II:** Map a set of IoT sensor feeds to an as-built BIM model's spaces and elements, and build a simple performance dashboard from the resulting data [Usage] **III:** Evaluate a building's digital-twin setup for sensor coverage, data quality, and its usefulness for predictive maintenance [Assessment]

Bibliography: [Grieves, 2011]

5.3 Asset Classification and Data Standards for FM, 24 hr(s)

Competences: AG-A05

Topics: I: Asset classification systems: Uniclass and OmniClass structures for organizing building elements and systems for FM use **II:** COBie schema in depth: component, type, system, space, and spare-parts worksheets, and how FM software consumes them

Learning Outcomes I: Describe how classification systems (Uniclass, OmniClass) and the COBie schema structure asset data for facilities management [Familiarity] **II:** Classify a BIM model's assets using a standard classification system, and populate the corresponding COBie worksheets [Usage] **III:** Evaluate an asset data set for correct classification and COBie schema completeness before FM handover [Assessment]

Bibliography: [Kensek, 2014]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: I: Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes I: Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Krygiel and Read, 2024]

6. Bibliography

[Grieves, 2011] Grieves, M. (2011). *Virtually Perfect: Driving Innovative and Lean Products through Product Lifecycle Management*. Space Coast Press, 1st edition.

[Kensek, 2014] Kensek, K. M. (2014). *Building Information Modeling*. Routledge, 1st edition.

[Krygiel and Read, 2024] Krygiel, E. and Read, P. (2024). *Mastering Autodesk Revit 2024*. Sybex, 1st edition.

[Teicholz, 2013] Teicholz, P. (2013). *BIM for Facility Managers*. Wiley / IFMA, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3D2 Design Studio VIII (Mandatory)

1. General information

- **Semester**: 8th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3D1 Design Studio VII (7th Sem-Pg. 159)

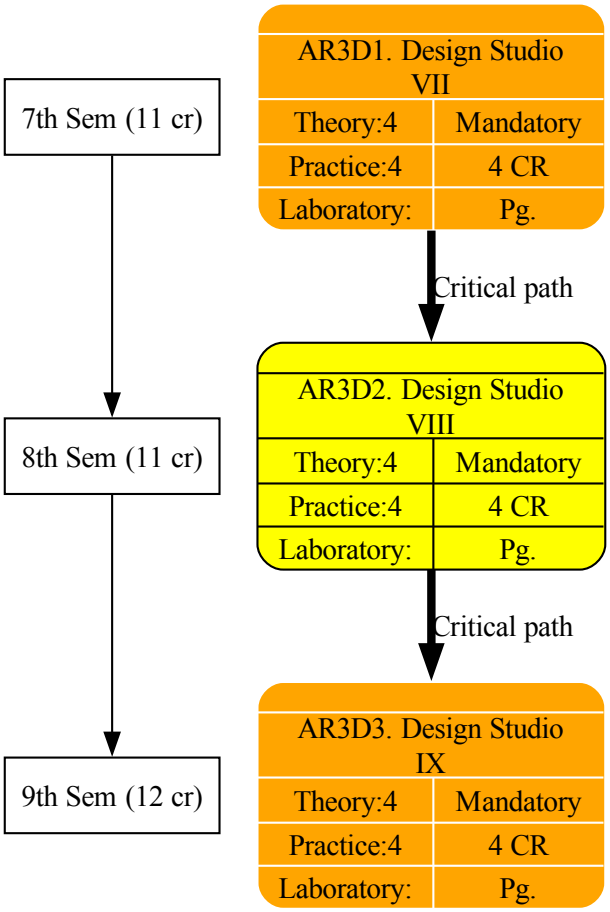


Figure 3.39: Connection Map. AR3D2 Design Studio VIII

2. Course Rationale

Design Studio VIII: Heritage and Complex Project follows the urban scale of Urban Design Studio VII (AR3D1, prerequisite) with a return to the building scale, now at a markedly higher level of complexity: students choose between the adaptive reuse of a historic building, or a large institutional project, as the specialization axis of this studio. The heritage track introduces the philosophical foundations and documentation methods of architectural conservation, the structural assessment of existing historic fabric, and the design strategies for adapting a historic building to new uses, including

circular-economy principles for material reuse. This course is the foundation for Design Studio IX (AR3D3).

3. Goals of the Course

- Apply the philosophical foundations and charters of architectural conservation (authenticity, integrity, minimal intervention) to the evaluation of a historic building or site.
- Document a historic building using appropriate survey methods (measured drawing, photogrammetry, or laser scanning) as the basis for a conservation or reuse proposal.
- Assess the structural condition of an existing historic building using non-destructive testing and monitoring methods.
- Design an adaptive reuse or large-scale institutional proposal that reconciles conservation principles (or complex-program integration) with contemporary programmatic requirements.
- Apply circular-economy principles – material reuse, design for disassembly – to the technical resolution of the design proposal.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Usage)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Usage)

AG-A14) Possesses creative capacity in construction techniques, grounded in a comprehensive understanding of the disciplines and construction methods related to architecture. (Usage)

5. Content

5.1 Theory and Philosophy of Conservation, 8 hr(s)

Competences: AG-A01

Topics: **I:** Historic conservation charters: Venice Charter (1964) - principles of minimum intervention, reversibility, anastylosis **II:** Philosophical debate in conservation: Ruskin's anti-restoration (building as ruin), Viollet-le-Duc's stylistic restoration (unity of style), Morris **III:** Core conservation principles: minimum intervention, reversibility, distinguishability of new work, compatibility of materials, documentation, **IV:** Values-based conservation: assigning values (historic, aesthetic, social, scientific, economic) and managing change through a conservation management plan **V:** Authenticity and integrity: authenticity of form, material, design, setting, and use; integrity as the intactness of the historic resource **VI:** Peru's Ley 28296 (Ley General del Patrimonio Cultural de la Nación): legal protection of heritage-declared buildings and sites, and the Ministerio de Cultura's authorization requirements for interventions on protected fabric

Learning Outcomes **I:** Describe the key conservation charters (Venice, Burra, Nara) and their principles: minimum intervention, reversibility, authenticity, and cultural significance [Familiarity] **II:** Apply a values-based conservation framework to a historic building or site, identifying its cultural, historic, and social values [Usage] **III:** Critically evaluate a conservation intervention proposal against the principles of the Venice and Burra Charters, assessing it for reversibility, compatibility, [Assessment]

Bibliography: [Feilden, 2003]

5.2 Adaptive Reuse and Building Transformation, 10 hr(s)

Competences: AG-A01

Topics: **I:** Adaptive reuse strategies: conversion of industrial buildings (warehouse, factory, mill) to residential, office, or cultural use; religious buildings to community space **II:** Designing additions to historic buildings: approach of contrast (Neue Nationalgalerie, Kolumba Museum)

vs. **III:** Interior adaptation of heritage buildings: inserting new floors and mezzanines, glazed interior partitions for program separation without structural change, MEP **IV:** Material reuse in adaptation: salvaged timber, brick, stone, and fixtures as design features; sourcing from deconstruction **V:** Code compliance in heritage adaptation: equivalency provisions (IBC Chapter 34, existing buildings), alternative means and methods, structural upgrades for seismic,

Learning Outcomes **I:** Describe the principal strategies for adaptive reuse of industrial, religious, and infrastructural heritage [Familiarity] **II:** Develop an adaptive reuse proposal for a historic building, including program analysis, insertion strategy (interior interventions, addition), [Usage] **III:** Evaluate an adaptive reuse project for its success in balancing heritage conservation with new program requirements, assessing the reversibility [Assessment]

Bibliography: [Stubbs, 2009]

5.3 Historic Documentation and Digital Survey, 8 hr(s)

Competences: AG-A10

Topics: **I:** Measured drawing of historic buildings: hand measuring (tape, laser distometer) to produce scaled plans, sections, and elevations **II:** Close-range photogrammetry: capturing overlapping images, processing with software (Agisoft Metashape, RealityCapture), generating 3D point clouds, meshes, **III:** Terrestrial laser scanning (TLS): time-of-flight and phase-shift scanners, registration, point cloud processing, and extraction of 2D drawings from 3D point clouds **IV:** Drone-based documentation: aerial photogrammetry and LiDAR for roof, facade, and site topography; flight planning, ground control points (GCPs), **V:** Condition assessment and monitoring: mapping decay patterns (efflorescence, spalling, cracking, biological growth) on drawings or point clouds

Learning Outcomes **I:** Describe the principal methods for documenting historic buildings - measured drawing, photogrammetry, laser scanning, and drone survey - and their appropriate scales [Familiarity] **II:** Produce measured drawings of a historic building or element using hand measurement, photogrammetry, or point cloud extraction, noting areas of material decay [Usage] **III:** Evaluate a documentation survey plan for a historic building, assessing the choice of method (photogrammetry vs [Assessment]

Bibliography: [Feilden, 2003]

5.4 Structural Assessment of Historic Buildings, 8 hr(s)

Competences: AG-A10

Topics: **I:** Non-destructive testing (NDT) for heritage: rebound hammer, ultrasonic pulse velocity (UPV), moisture meters, endoscopy, thermal imaging, **II:** Small-sample and minimally invasive testing: core sampling for compressive strength, mortar analysis (chemical composition, binder/aggregate ratio), timber dendrochronology, **III:** Structural monitoring of historic buildings: crack monitoring (glass telltales, mechanical gauges, electronic displacement sensors), tilt meters, **IV:** Structural modeling for heritage: interpreting historic construction techniques (masonry vaults, timber frames, iron elements), simplified analysis (limit state for masonry), **V:** Decay mechanisms in historic structures: differential settlement, thrust from vaults, water ingress (freeze-thaw, salt crystallization), timber decay (rot, insect attack),

Learning Outcomes **I:** Describe the principal non-destructive testing methods for historic building assessment and identify the decay mechanisms commonly found in historic masonry, timber, [Familiarity] **II:** Develop a structural assessment plan for a historic building, selecting appropriate NDT and monitoring methods based on materials, decay patterns, and suspected failure mechanisms [Usage] **III:** Evaluate the structural condition of a historic building from monitoring data and on-site observations, diagnosing the likely causes of cracking or deformation [Assessment]

Bibliography: [Feilden, 2003]

5.5 Large-Scale and Complex Buildings, 12 hr(s)

Competences: AG-A14

Topics: **I:** Programming and spatial organization at large scale: stacking diagrams, core-to-perimeter ratios, vertical circulation strategies, **II:** Life safety and means of egress in large buildings: occupancy-based egress design, pressurized stairwells, refuge floors, fire compartmentalization, and NFPA/IBC requirements **III:** Vertical transportation systems: elevator group design, sky lobbies, express/local zone strategies, escalators, and integration of vertical transport into building form **IV:** Hybrid and mixed-use building design: separating and linking residential, commercial, hotel, and civic programs; transfer floors, podium strategies, and shared amenity programming **V:** Phased construction and building complexity: designing for construction staging, operational continuity, future expansion, and changeable use within long-lifespan complex buildings **VI:** Campus and master plan design at large scale: site organization, wayfinding, public realm, phasing, infrastructure coordination, and identity across a multi-building ensemble

Learning Outcomes **I:** Identify the key design challenges - program complexity, life safety, vertical transport, and phasing - that distinguish large-scale buildings from smaller architectural projects [Familiarity] **II:** Apply large-scale building design strategies to develop a spatial and programmatic organization for a complex multi-story or mixed-use building typology [Usage] **III:** Evaluate a large-scale building design for programmatic coherence, life safety compliance, and operational efficiency [Assessment]

Bibliography: [Stubbs, 2009]

5.6 Circular and Recycled Materials, 8 hr(s)

Competences: AG-A14

Topics: **I:** Circular economy in construction: the hierarchy of reuse (refurbish, repurpose, recycle, recover); Ellen MacArthur Foundation framework applied to building materials and components **II:** Design for disassembly: reversible connections (bolted vs. welded, dry vs. wet joints), accessible fasteners, standardized component dimensions, **III:** Material passports and digital product declarations: documenting material composition, structural properties, and reuse potential **IV:** Recycled content specifications: recycled steel (EAF vs. BF), recycled concrete aggregate (RCA), reclaimed timber, **V:** Adaptive reuse technical assessment: structural capacity evaluation of existing buildings, floor-to-floor height compatibility for new uses, facade retention feasibility, **VI:** Urban mining and deconstruction: selective demolition methodologies, material recovery rates, contamination testing,

Learning Outcomes **I:** Describe the principles of circular construction, including design for disassembly, material passports, and recycled content specification, [Familiarity] **II:** Apply circular economy principles to a building design, specifying recycled and reclaimed materials and designing connections and assemblies that support future disassembly [Usage] **III:** Evaluate a building design or renovation project for circular economy compliance, scoring it against a material passport framework [Assessment]

Bibliography: [Ellen MacArthur Foundation, 2019]

6. Bibliography

[Ellen MacArthur Foundation, 2019] Ellen MacArthur Foundation (2019). Circular economy in the built environment. Ellen MacArthur Foundation Report.

[Feilden, 2003] Feilden, B. M. (2003). *Conservation of Historic Buildings*. Architectural Press, 3rd edition.

[Stubbs, 2009] Stubbs, J. H. (2009). *Time Honored: A Global View of Architectural Conservation*. Wiley.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR401 Statistics and Research Instruments (Mandatory)

1. General information

- **Semester**: 8th Sem. **Credits**: 3
- **Hour of this course**: **Theory**: 2 hours; **Practice**: 2 hours;
- **Prerrequisites**:
  - AR400 Scientific Research Methodology (7th Sem-Pg. 163)

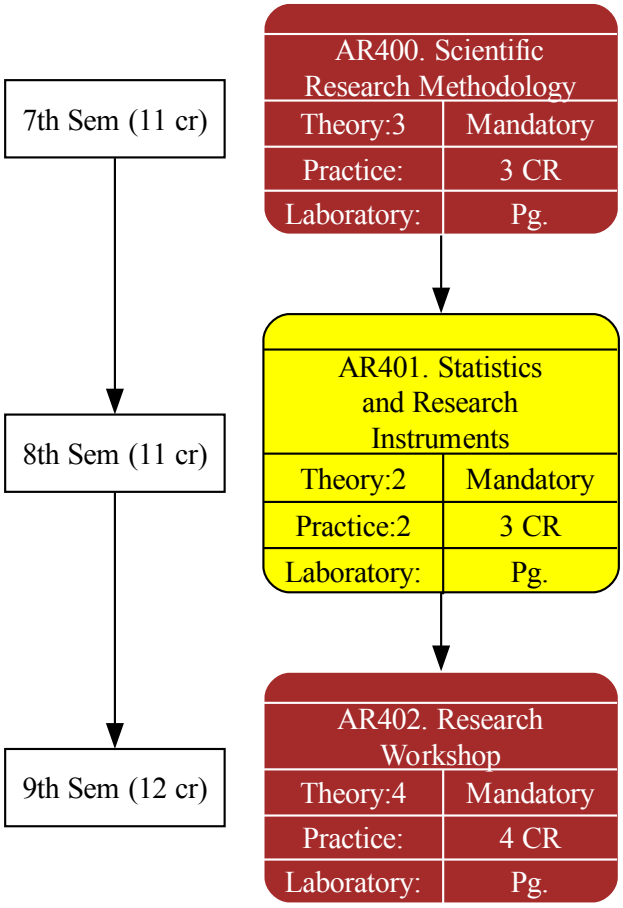


Figure 3.40: Connection Map. AR401 Statistics and Research Instruments

2. Course Rationale

Statistics and Research Instruments is the second course of the research track, taking the research-design foundation from Scientific Research Methodology (ARC400) and adding the quantitative-analysis and instrument-design toolkit – descriptive statistics, estimation, hypothesis testing, simple regression – that Research Workshop (ARC402) will assume students can apply unsupervised to their own thesis data.

3. Goals of the Course

- Summarize territorial/urban datasets using numerical measures of location, spread, and shape.
- Estimate population parameters from sample data (point and interval estimation) and interpret confidence intervals in a territorial context.
- Formulate and test statistical hypotheses about urban phenomena, interpreting significance correctly.
- Fit and interpret a simple linear regression model relating two urban variables.
- Design and validate data-collection instruments (surveys, structured interviews, observation forms) for a specific research question, including reliability and validity checks.

4. General Competences (*Outcomes*)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Assessment)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Assessment)

5. Content

5.1 Numerical Summaries: Location, Spread, and Shape, 12 hr(s)

Competences: AG-A07

Topics: **I:** Measures of location: mean, median, mode, trimmed mean, and weighted mean **II:** Measures of spread: variance, standard deviation, IQR, MAD, and range **III:** Measures of shape: skewness and kurtosis; quantiles and percentiles **IV:** Robust summary statistics: resistance to outliers and heavy-tailed distributions

Learning Outcomes **I:** Calculate and interpret measures of location, spread, and shape for a univariate dataset [Usage] **II:** Select appropriate summary statistics based on the distributional properties of the data [Usage] **III:** Compare classical and robust summary statistics and justify the choice for a given dataset [Assessment]

Bibliography: [Moore et al., 2017]

5.2 Point Estimation, 10 hr(s)

Competences: AG-A07

Topics: **I:** Desirable properties: unbiasedness, consistency, efficiency, and sufficiency **II:** Method of moments estimation: derivation and asymptotic properties **III:** Maximum likelihood estimation: derivation, properties, and invariance principle **IV:** Cramer-Rao lower bound and the concept of Fisher information

Learning Outcomes **I:** Describe the key properties of estimators and explain the trade-offs between them [Familiarity] **II:** Derive method of moments and MLE estimators for standard distributions [Usage] **III:** Evaluate the efficiency of an estimator using the Cramer-Rao lower bound [Assessment]

Bibliography: [Moore et al., 2017]

5.3 Interval Estimation and Confidence Intervals, 10 hr(s)

Competences: AG-A07

Topics: **I:** Constructing confidence intervals using pivotal quantities and exact distributions **II:** Correct interpretation of confidence intervals: coverage probability and common misconceptions **III:** Large-sample confidence intervals based on asymptotic normality **IV:** Duality between confidence intervals and hypothesis tests

Learning Outcomes I: Construct confidence intervals for means, proportions, and variances using exact and large-sample methods [Usage] **II:** Interpret confidence intervals correctly and identify common misinterpretations [Usage] **III:** Explain the duality between confidence intervals and hypothesis tests and use it to draw inferences [Assessment]

Bibliography: [Moore et al., 2017]

5.4 Hypothesis Testing Foundations, 10 hr(s)

Competences: AG-A10

Topics: I: Neyman-Pearson framework: null/alternative hypotheses, rejection regions, Type I and II errors **II:** p-values: definition, correct interpretation, and common misuse; power and sample size **III:** Common parametric tests: z-test, t-test, F-test, chi-squared test **IV:** Neyman-Pearson lemma and uniformly most powerful tests

Learning Outcomes I: Explain the logic of hypothesis testing, Type I and II errors, and the meaning of a p-value [Familiarity] **II:** Apply standard parametric tests and interpret the results in context [Usage] **III:** Derive the most powerful test for a simple hypothesis using the Neyman-Pearson lemma [Assessment]

Bibliography: [Moore et al., 2017]

5.5 Simple Linear Regression, 10 hr(s)

Competences: AG-A10

Topics: I: Ordinary least squares estimation: derivation of coefficients and their properties **II:** Inference for regression coefficients: t-tests, confidence intervals, and p-values **III:** Coefficient of determination R-squared and analysis of variance decomposition **IV:** Gauss-Markov theorem: BLUE property of OLS under classical assumptions

Learning Outcomes I: Fit a simple linear regression model and interpret the estimated coefficients [Usage] **II:** Conduct hypothesis tests and construct confidence intervals for regression parameters [Usage] **III:** Verify the Gauss-Markov assumptions and assess their consequences when violated [Assessment]

Bibliography: [Moore et al., 2017]

5.6 Research Hypotheses and Variables, 12 hr(s)

Competences: AG-A10

Topics: I: Types of hypotheses: null, alternative, directional, and non-directional, and their relationship to research questions **II:** Classification of variables: independent, dependent, control, and confounding **III:** Operationalizing variables: defining measurable indicators and measurement scales (nominal, ordinal, interval, ratio) **IV:** Relationship between hypotheses, variables, and statistical significance tests: significance level, Type I and Type II error **V:** Graphical representation of the relationship between variables through conceptual or operational models

Learning Outcomes I: Distinguish between null and alternative hypotheses, and between independent, dependent, and control variables, in a civil engineering research problem [Familiarity] **II:** Formulate a testable research hypothesis and operationalize its variables for a specific problem in the chosen specialization area [Usage] **III:** Evaluate the consistency between the theoretical framework, the stated hypothesis, and the proposed data-collection design [Assessment]

Bibliography: [Salkind, 2017]

6. Bibliography

[Moore et al., 2017] Moore, D. S., McCabe, G. P., and Craig, B. A. (2017). *Introduction to the Practice of Statistics*. W. H. Freeman, 9th edition.

[Salkind, 2017] Salkind, N. J. (2017). *Statistics for People Who (Think They) Hate Statistics*. SAGE Publications, 6th edition.

Ninth Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3B4 Heritage and Infrastructure (Mandatory)

1. General information

- **Semester**: 9th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3B3 Facilities Management (8th Sem-Pg. 167)

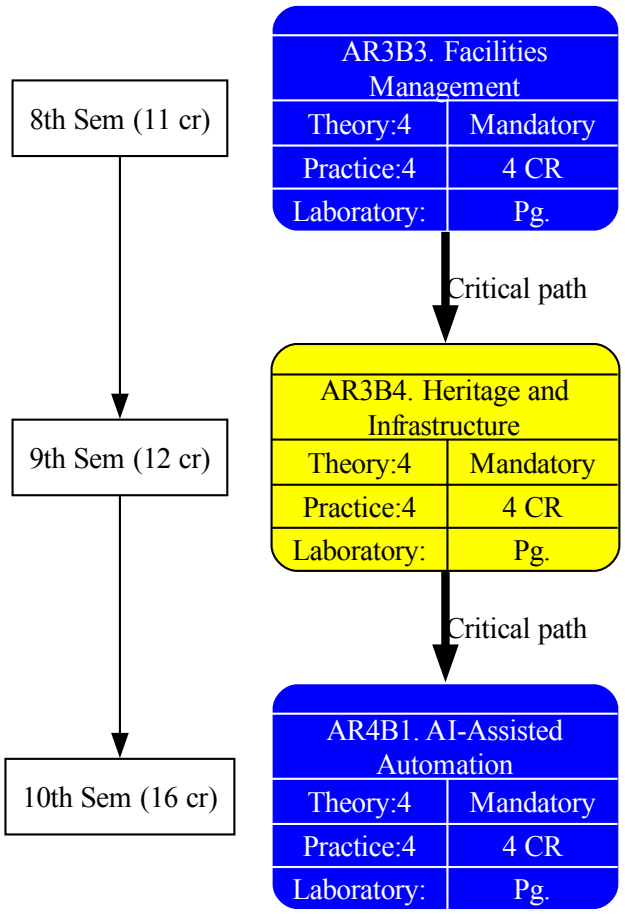


Figure 3.41: Connection Map. AR3B4 Heritage and Infrastructure

2. Course Rationale

Heritage and Infrastructure is the ninth course of the ten-course BIM I-X sequence, building on the authoring, coordination, scheduling, cost, sustainability, and facilities-management workflows developed through Facilities Management (AR3B3, prerequisite). It takes BIM methods beyond the conventional new-build vertical building: Heritage BIM (HBIM) for documenting and monitoring

historic fabric, BIM's extension to horizontal/civil infrastructure and city-scale urban information modeling, and reality-capture techniques (laser scanning, photogrammetry) that ground any of these models in verified real-world geometry. Together with the recurring BIM Software Practicum, it equips students with the specialized BIM skill set needed for heritage conservation, infrastructure, and as-built documentation practice, immediately ahead of the sequence's integrative capstone course, AI-Assisted Automation.

3. Goals of the Course

- Author a Heritage BIM (HBIM) model of a historic building element from laser-scan data, enriching it with semantic conservation data (material, decay condition, past interventions).
- Extend BIM authoring beyond the single building to horizontal infrastructure and city-scale urban information models, integrating building-scale BIM with city-scale GIS data.
- Capture real-world geometry through laser scanning and photogrammetry and use the resulting point clouds or meshes as a modeling and as-built verification reference inside a BIM authoring tool.
- Complete a sequence of guided, certification-aligned software exercises building toward a cumulative BIM practicum deliverable.

4. General Competences (*Outcomes*)

AG-A01) Evaluates the impact of architectural solutions on sustainable development, economy, health and safety, the legal framework, architectural-urban heritage, and the environment. (Usage)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Usage)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Usage)

5. Content

5.1 Heritage BIM (HBIM), 24 hr(s)

Competences: AG-A01

Topics: **I:** Heritage BIM (HBIM): object-oriented modeling of historic buildings using non-parametric (discrete) and parametric libraries **II:** Scan-to-BIM workflow: processing point clouds from laser scanning to create 3D models with semantic decomposition (walls, vaults, windows) **III:** Semantic enrichment for heritage: adding conservation data (material type, decay grade, past interventions, monitoring history) to BIM objects **IV:** Digital twins for heritage: integrating real-time monitoring sensors (cracks, displacement, humidity, temperature) with HBIM **V:** HBIM standards and guidelines: ICOMOS HBIM Guidelines, CIDOC CRM for cultural heritage data, and the integration of HBIM with conservation management plan data fields

Learning Outcomes **I:** Describe the concept of Heritage BIM (HBIM) and explain how it differs from conventional BIM in terms of geometry representation and semantic data [Familiarity] **II:** Create an HBIM model of a historic building element (vault, window, wall) from laser scan data, enriching it with semantic data (material, decay condition, past interventions) [Usage] **III:** Evaluate a proposed HBIM workplan for a heritage project, assessing the level of detail required for documentation and the compatibility of data schema with monitoring needs [Assessment]

Bibliography: [Murphy et al., 2009]

5.2 BIM for Infrastructure and Urban Modeling, 24 hr(s)

Competences: AG-A07

Topics: **I:** BIM for horizontal/civil infrastructure: roads, bridges, and utility networks modeled with alignment-based and corridor-modeling tools (Civil 3D, InfraWorks), distinct from vertical-building BIM authoring **II:** City Information Modeling (CIM) and urban digital twins: integrating building-scale BIM with city-scale GIS data (CityGML, 3D Tiles) for planning and infrastructure coordination

Learning Outcomes **I:** Describe how BIM methods extend to horizontal infrastructure and city-scale modeling, and identify the tools and data standards specific to each scale [Familiarity] **II:** Model a piece of infrastructure (road segment, utility corridor) using alignment-based BIM tools, and integrate it with an urban-scale GIS dataset [Usage] **III:** Evaluate an infrastructure or city-information model for data interoperability between building-scale BIM and city-scale GIS systems [Assessment]

Bibliography: [Costin et al., 2018]

5.3 Reality Capture for BIM: Point Clouds and Photogrammetry, 24 hr(s)

Competences: AG-A06

Topics: **I:** Laser scanning workflows: terrestrial and handheld scanner data capture, registration of multiple scans, and point-cloud cleanup **II:** Photogrammetric reconstruction: structure-from-motion processing of overlapping photographs (drone or handheld) into dense point clouds and textured meshes **III:** Working from point-cloud or mesh references inside a BIM authoring tool: underlay referencing, scan-based dimension checking, and as-built verification against design models

Learning Outcomes **I:** Describe how laser scanning and photogrammetry capture real-world geometry as point-cloud or mesh data usable inside a BIM authoring tool [Familiarity] **II:** Register a set of scans or photographs into a point cloud, and use it as a reference to verify or model an as-built condition in BIM [Usage] **III:** Evaluate a reality-capture data set for registration accuracy and its adequacy as a reference for as-built BIM modeling [Assessment]

Bibliography: [Luhmann et al., 2019]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A06

Topics: **I:** Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes **I:** Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Weygant, 2011]

6. Bibliography

[Costin et al., 2018] Costin, A., Adibfar, A., Hu, H., and Chen, S. S. (2018). Building information modeling (bim) for transportation infrastructure – literature review, applications, challenges, and recommendations. *Automation in Construction*, 94:257–281.

[Luhmann et al., 2019] Luhmann, T., Robson, S., Kyle, S., and Boehm, J. (2019). *Close-Range Photogrammetry and 3D Imaging*. De Gruyter, 3rd edition.

[Murphy et al., 2009] Murphy, M., McGovern, E., and Pavia, S. (2009). Historic building information modelling (hbim). *Structural Survey*, 27(4):311–327.

[Weygant, 2011] Weygant, R. S. (2011). *BIM Content Development: Standards, Strategies, and Best Practices*. Wiley, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3D3 Design Studio IX (Mandatory)

1. General information

- **Semester**: 9th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3D2 Design Studio VIII (8th Sem-Pg. 170)

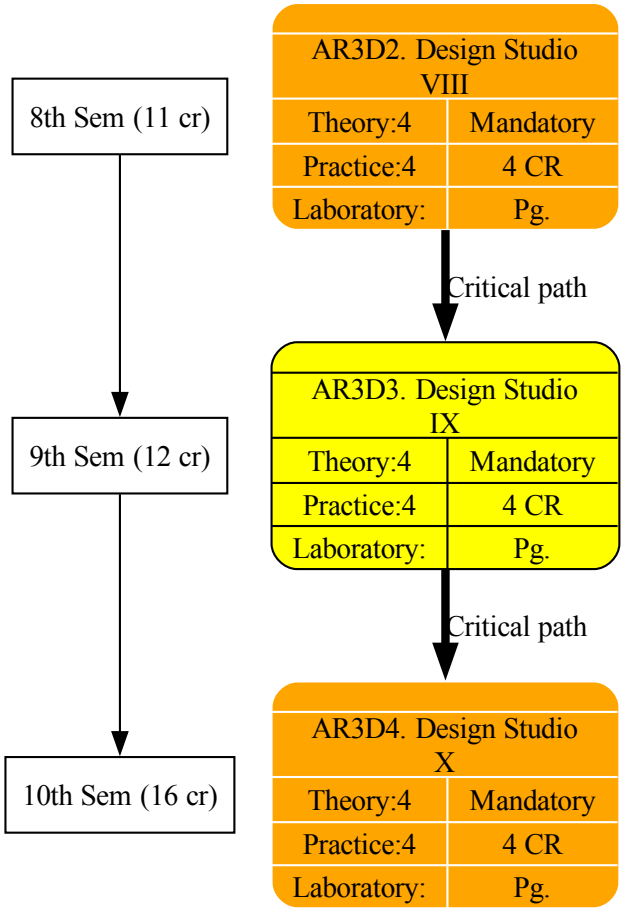


Figure 3.42: Connection Map. AR3D3 Design Studio IX

2. Course Rationale

Design Studio IX: Metropolitan Infrastructure and Civic Facility raises the sequence's scale and program complexity once more after Design Studio VIII (AR3D2, prerequisite), to the metropolitan scale: students design a high-complexity civic facility – a transit terminal, a stadium, a convention center – whose scale requires long-span structural systems and an explicit integration with the city's urban structure, alongside the development feasibility analysis appropriate to a project of this magnitude. This course is the foundation for the sequence's final, most comprehensive studio, Design Studio X (AR3D4).

3. Goals of the Course

- Design the programming and spatial organization of a high-complexity civic facility at metropolitan scale.
- Design long-span structural systems (trusses, space frames, shells, or tensile structures) appropriate to a large-scale civic facility.
- Integrate the civic facility's design with the city's structure across scales – from the regional network down to its immediate urban context.
- Coordinate the structural, envelope, and building-system assemblies required by a large-scale, high-complexity building.
- Evaluate the development feasibility of a metropolitan-scale civic facility, including market, regulatory, and financial constraints.

4. General Competences (*Outcomes*)

AG-A08) Understands the structural and environmental design problems associated with construction and the engineering of building design. (Usage)

AG-A09) Creates architectural designs that satisfy aesthetic and technical requirements. (Usage)

AG-A12) Possesses the design skills needed to satisfy building users' requirements within cost constraints and building regulations. (Usage)

5. Content

5.1 Large-Scale and Complex Buildings, 14 hr(s)

Competences: AG-A09

Topics: **I:** Programming and spatial organization at large scale: stacking diagrams, core-to-perimeter ratios, vertical circulation strategies, **II:** Life safety and means of egress in large buildings: occupancy-based egress design, pressurized stairwells, refuge floors, fire compartmentalization, and NFPA/IBC requirements **III:** Vertical transportation systems: elevator group design, sky lobbies, express/local zone strategies, escalators, and integration of vertical transport into building form **IV:** Hybrid and mixed-use building design: separating and linking residential, commercial, hotel, and civic programs; transfer floors, podium strategies, and shared amenity programming **V:** Phased construction and building complexity: designing for construction staging, operational continuity, future expansion, and changeable use within long-lifespan complex buildings **VI:** Campus and master plan design at large scale: site organization, wayfinding, public realm, phasing, infrastructure coordination, and identity across a multi-building ensemble

Learning Outcomes **I:** Identify the key design challenges - program complexity, life safety, vertical transport, and phasing - that distinguish large-scale buildings from smaller architectural projects [Familiarity] **II:** Apply large-scale building design strategies to develop a spatial and programmatic organization for a complex multi-story or mixed-use building typology [Usage] **III:** Evaluate a large-scale building design for programmatic coherence, life safety compliance, and operational efficiency [Assessment]

Bibliography: [Schierle, 2012]

5.2 Urban Design at Multiple Scales, 10 hr(s)

Competences: AG-A09

Topics: **I:** Regional and city scale: transit corridors, green belts, growth boundaries, satellite towns, and the relationship between density **II:** Neighborhood scale: walkability (5-10 minute walking radius), mixed-use zoning, social infrastructure (schools, clinics, community centers), and the

20-minute neighborhood concept **III:** Block and street scale: block length for pedestrian permeability (80-120 m max), street section design (lane widths, sidewalks, bike lanes, street trees, furniture zone), **IV:** Public space design: squares, plazas, parks, pocket parks, and streets as public space; William Whyte's elements of successful public space (sittable space, sun, food **V:** Urban design guidelines: building setbacks, height limits, architectural character, facade articulation, signage, lighting,

Learning Outcomes I: Describe the key design considerations at each urban scale - regional, neighborhood, block, street, and public space - [Familiarity] **II:** Develop a set of urban design guidelines for a specific neighborhood or street typology, integrating density, building height, block length, street section, [Usage] **III:** Evaluate an urban design project for its multi-scale coherence, assessing how well it integrates regional transit, neighborhood walkability, block permeability, street safety, [Assessment]

Bibliography: [Lynch, 1960]

5.3 Long-Span and Special Structures, 12 hr(s)

Competences: AG-A08

Topics: I: Arches and vaults: funicular compression geometry, buttressing requirements, ribbed vs. continuous vaults, and historic and contemporary applications (Guastavino, Candela) **II:** Domes and shells: membrane theory, edge ring forces, buckling in thin shells, geodesic domes (Fuller), and reinforced concrete shells (Nervi, Isler) **III:** Space frames and long-span trusses: three-dimensional truss action, node design, modular systems (Mero, Unistrut), and application in arenas, airports, and exhibition halls **IV:** Tensile and cable structures: cable nets (Frei Otto), fabric membranes (PTFE-coated fiberglass, ETFE), masts and anchorage design, and form-finding via physical **V:** Folded plate structures: corrugated geometry for stiffness, folded plate concrete roofs, and timber folded plate systems (CLT folded plates) **VI:** Deployable and transformable structures: scissor linkages, pantographic systems, and their application in retractable roofs, emergency shelters, and kinetic architecture

Learning Outcomes I: Describe the principal long-span structural systems - arches, domes, space frames, tensile membranes - and identify the appropriate span range [Familiarity] **II:** Select and conceptualize a long-span structural system for a given program (e.g., stadium, airport terminal, convention center), justifying the choice by span, load, [Usage] **III:** Evaluate the structural efficiency and architectural expression of a built long-span structure, analyzing its load path, stability, and integration of form with structural logic [Assessment]

Bibliography: [Schierle, 2012]

5.4 Building Systems and Assemblies, 10 hr(s)

Competences: AG-A08

Topics: I: Integration of building systems: coordinating structural frame, mechanical/electrical/plumbing (MEP), envelope, and interior fit-out within constrained floor-to-floor heights **II:** Construction documentation for assemblies: details at 1:5, 1:10, and 1:20; section-through-wall details, sill and head conditions, and coordination between architectural **III:** Construction tolerances and coordination: dimensional tolerances in concrete, steel, and masonry; clearances for MEP rough-in **IV:** Waterproofing and moisture management: below-grade waterproofing systems, drainage planes, vapor barriers, and flashing at penetrations **V:** Fire-rated assemblies: UL-listed wall, floor, and ceiling assemblies; fire-stopping at penetrations, intumescent seals, and the architectural detailing required by fire codes **VI:** Prefabricated and modular assemblies: volumetric modular construction, panelized wall systems, and the design implications of off-site manufacturing tolerances

Learning Outcomes I: Identify the principal building systems and describe how they are integrated and coordinated within a multi-story building assembly [Familiarity] **II:** Develop construction-level details for a building assembly that correctly coordinate structural, envelope, and MEP systems within realistic tolerances and code requirements [Usage] **III:** Evaluate a set of construction documents for assembly coordination quality, identifying conflicts, missing details, and buildability risks [Assessment]

Bibliography: [Allen and Iano, 2019]

5.5 Development Process and Feasibility, 8 hr(s)

Competences: AG-A12

Topics: I: Development phases: site identification, option agreement, due diligence, entitlement (zoning, permits), design **II:** Due diligence for development sites: title review, environmental assessment (Phase I and II), geotechnical investigation, zoning analysis, utility availability, **III:** Entitlements and permitting: land use approvals (rezoning, variances, conditional use permits), building permits, impact fees (school, traffic, parks) **IV:** Feasibility study components: market support, site suitability, regulatory pathway, construction feasibility, financial pro forma (with sensitivity analysis), **V:** Real estate pro forma basics: projected net operating income (NOI = gross potential rent minus vacancy allowance minus operating expenses), debt service coverage ratio (DSCR),

Learning Outcomes I: Describe the major stages of the real estate development process - predevelopment, construction, lease-up, disposition - and the due diligence [Familiarity] **II:** Prepare a feasibility study for a proposed development, including market analysis, site due diligence summary, entitlement pathway, construction cost estimate, [Usage] **III:** Evaluate a development pro forma for financial viability, identifying understated risk (vacancy, construction contingency) [Assessment]

Bibliography: [Miles et al., 2007]

6. Bibliography

[Allen and Iano, 2019] Allen, E. and Iano, J. (2019). *Fundamentals of Building Construction: Materials and Methods*. Wiley, 7th edition.

[Lynch, 1960] Lynch, K. (1960). *The Image of the City*. MIT Press.

[Miles et al., 2007] Miles, M. E., Berens, G., and Weiss, M. A. (2007). *Real Estate Development: Principles and Process*. Urban Land Institute, 4th edition.

[Schierle, 2012] Schierle, G. G. (2012). *Architectural Structures*. University of Southern California.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR402 Research Workshop (Mandatory)

1. General information

- **Semester**: 9th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours;
- **Prerrequisites**:
  - AR401 Statistics and Research Instruments (8th Sem-Pg. 174)

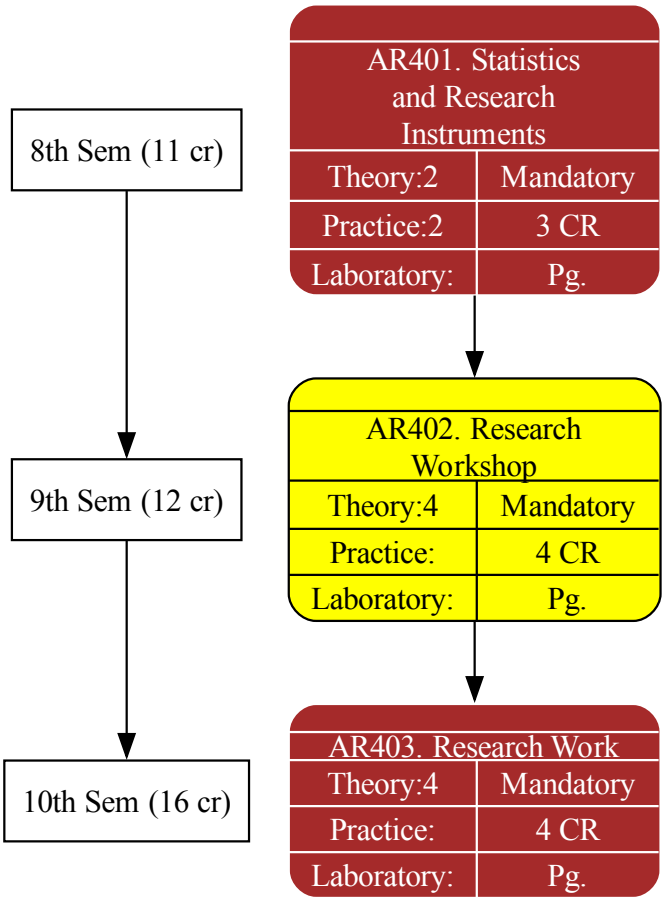


Figure 3.43: Connection Map. AR402 Research Workshop

2. Course Rationale

Research Workshop is the applied, tutored counterpart of Scientific Research Methodology (ARC400) and Statistics (ARC401): instead of learning methods in the abstract, each student designs their own non-experimental research proposal on a real territorial problem, culminating in a consistency matrix. This mirrors the existing Thesis I course (AR401), reusing the same three Research KUs (Design, Theoretical Framework, Hypotheses and Variables) without the design-studio-specific unit, since this track's output is a research proposal, not a design project.

3. Goals of the Course

- Formulate hypotheses and operationalize the variables of a territorial or urban research problem chosen by the student.
- Select and justify a research design appropriate to the student's own thesis topic, applying the methods learned in ARC400.
- Build the theoretical framework and state of the art of the student's own research proposal.
- Produce a complete, internally consistent research proposal (consistency matrix) ready to be executed in Research Work (ARC403).

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Assessment)

5. Content

5.1 Research Design and Methodologies, 20 hr(s)

Competences: AG-A10

Topics: **I:** Formulating research questions in architecture: descriptive, relational, causal; turning design problems into researchable questions **II:** Choosing a research methodology: quantitative (hypothesis testing, statistical), qualitative (interpretive, case study), mixed methods, **III:** Validity and reliability in architectural research: internal validity, external validity (generalizability), construct validity, **IV:** Research ethics in architectural research: informed consent, privacy (anonymization of building users), institutional review board (IRB) protocols, **V:** Mixed methods research: sequential (qualitative then quantitative) and concurrent designs; integrating qualitative findings (user interviews) with quantitative data (occupancy

Learning Outcomes **I:** Describe the main research methodologies in architecture - quantitative, qualitative, mixed methods, practice-based - and explain their appropriate applications [Familiarity] **II:** Develop a research design for an architectural inquiry, including research question, literature review, methodology selection, data collection protocol, and analysis plan [Usage] **III:** Evaluate the research design of a published architectural study for validity, reliability, and ethical soundness, identifying methodological strengths and weaknesses [Assessment]

Bibliography: [Creswell and Creswell, 2018, Groat and Wang, 2013]

5.2 Theoretical Framework and Literature Review, 20 hr(s)

Competences: AG-A04

Topics: **I:** Systematic search of scientific and technical literature: specialized databases (Scopus, Web of Science, ASCE Library), keywords, and Boolean operators **II:** Critical reading and synthesis of scientific articles, technical standards, and prior research reports **III:** Building the conceptual and theoretical framework: defining key concepts, relationships between variables, and reference theoretical models **IV:** Identifying knowledge gaps (research gap) and justifying the originality of the proposed contribution **V:** Bibliographic reference management and citation styles (APA, IEEE) using tools such as Zotero or Mendeley

Learning Outcomes **I:** Explain the structure and purpose of a theoretical framework within a civil engineering research project [Familiarity] **II:** Conduct a systematic search of scientific and technical literature on a chosen research topic using specialized databases [Usage] **III:** Synthesize the state of the art of a research topic into a coherent theoretical framework that identifies a knowledge gap [Assessment]

Bibliography: [Creswell and Creswell, 2018, Groat and Wang, 2013]

5.3 Research Hypotheses and Variables, 16 hr(s)

Competences: AG-A10

Topics: **I:** Types of hypotheses: null, alternative, directional, and non-directional, and their relationship to research questions **II:** Classification of variables: independent, dependent, control, and confounding **III:** Operationalizing variables: defining measurable indicators and measurement scales (nominal, ordinal, interval, ratio) **IV:** Relationship between hypotheses, variables, and statistical significance tests: significance level, Type I and Type II error **V:** Graphical representation of the relationship between variables through conceptual or operational models

Learning Outcomes **I:** Distinguish between null and alternative hypotheses, and between independent, dependent, and control variables, in a civil engineering research problem [Familiarity] **II:** Formulate a testable research hypothesis and operationalize its variables for a specific problem in the chosen specialization area [Usage] **III:** Evaluate the consistency between the theoretical framework, the stated hypothesis, and the proposed data-collection design [Assessment]

Bibliography: [Creswell and Creswell, 2018, Salkind, 2017]

6. Bibliography

[Creswell and Creswell, 2018] Creswell, J. W. and Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications, 5th edition.

[Groat and Wang, 2013] Groat, L. N. and Wang, D. (2013). *Architectural Research Methods*. Wiley, 2nd edition.

[Salkind, 2017] Salkind, N. J. (2017). *Statistics for People Who (Think They) Hate Statistics*. SAGE Publications, 6th edition.

Tenth Semester

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR3D4 Design Studio X (Mandatory)

1. General information

- **Semester**: 10th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3D3 Design Studio IX (9th Sem-Pg. 182)

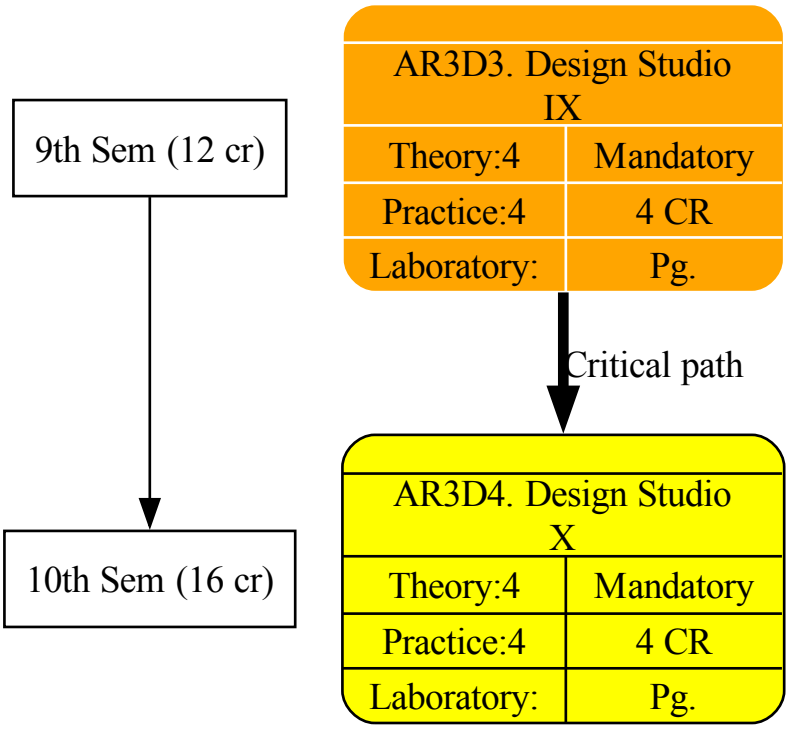


Figure 3.44: Connection Map. AR3D4 Design Studio X

2. Course Rationale

Design Studio X: Comprehensive Architectural Project closes the Design Studio sequence that began in Design Studio I (AR1D1) and continued through Design Studio IX (AR3D3, prerequisite). Students develop a high-complexity anteproyecto (preliminary design) that integrates, for the first time within a single project, every major dimension practiced across the sequence: a complex building program, a fully coordinated structural and systems assembly, net-zero-oriented sustainability strategies, and Building Information Modeling as the representational and coordination platform, all verified against applicable building codes. Unlike the Tesis sequence (AR401-AR403), this course does not involve thesis research or an individual defense: it is the Design Studio sequence's comprehensive, integrative capstone project.

3. Goals of the Course

- Develop a comprehensive architectural anteproyecto that integrates complex programming, structural logic, and building systems into a single coherent design proposal.
- Coordinate the structural, envelope, and building-system assemblies of the comprehensive project into a constructible whole.
- Apply net-zero and high-performance sustainability strategies (energy modeling, efficiency-first design, on-site renewables) to the comprehensive project.
- Develop and coordinate the comprehensive project using Building Information Modeling, from conceptual massing to a construction- ready level of development.
- Verify the comprehensive project's compliance with applicable building codes and regulations.

4. General Competences (*Outcomes*)

AG-A09) Creates architectural designs that satisfy aesthetic and technical requirements. (Usage)

AG-A12) Possesses the design skills needed to satisfy building users' requirements within cost constraints and building regulations. (Usage)

AG-A13) Demonstrates knowledge of the means to achieve ecologically responsible design and environmental conservation and rehabilitation. (Usage)

5. Content

5.1 Large-Scale and Complex Buildings, 16 hr(s)

Competences: AG-A09

Topics: **I:** Programming and spatial organization at large scale: stacking diagrams, core-to-perimeter ratios, vertical circulation strategies, **II:** Life safety and means of egress in large buildings: occupancy-based egress design, pressurized stairwells, refuge floors, fire compartmentalization, and NFPA/IBC requirements **III:** Vertical transportation systems: elevator group design, sky lobbies, express/local zone strategies, escalators, and integration of vertical transport into building form **IV:** Hybrid and mixed-use building design: separating and linking residential, commercial, hotel, and civic programs; transfer floors, podium strategies, and shared amenity programming **V:** Phased construction and building complexity: designing for construction staging, operational continuity, future expansion, and changeable use within long-lifespan complex buildings **VI:** Campus and master plan design at large scale: site organization, wayfinding, public realm, phasing, infrastructure coordination, and identity across a multi-building ensemble

Learning Outcomes **I:** Identify the key design challenges - program complexity, life safety, vertical transport, and phasing - that distinguish large-scale buildings from smaller architectural projects [Familiarity] **II:** Apply large-scale building design strategies to develop a spatial and programmatic organization for a complex multi-story or mixed-use building typology [Usage] **III:** Evaluate a large-scale building design for programmatic coherence, life safety compliance, and operational efficiency [Assessment]

Bibliography: [Schierle, 2012]

5.2 Building Systems and Assemblies, 12 hr(s)

Competences: AG-A09

Topics: **I:** Integration of building systems: coordinating structural frame, mechanical/electrical/plumbing (MEP), envelope, and interior fit-out within constrained floor-to-floor heights **II:** Construction documentation for assemblies: details at 1:5, 1:10, and 1:20; section-through-wall details, sill and head conditions, and coordination between architectural **III:** Construction tolerances and coordination: dimensional tolerances in concrete, steel, and masonry; clearances for MEP

rough-in **IV:** Waterproofing and moisture management: below-grade waterproofing systems, drainage planes, vapor barriers, and flashing at penetrations **V:** Fire-rated assemblies: UL-listed wall, floor, and ceiling assemblies; fire-stopping at penetrations, intumescent seals, and the architectural detailing required by fire codes **VI:** Prefabricated and modular assemblies: volumetric modular construction, panelized wall systems, and the design implications of off-site manufacturing tolerances

Learning Outcomes **I:** Identify the principal building systems and describe how they are integrated and coordinated within a multi-story building assembly [Familiarity] **II:** Develop construction-level details for a building assembly that correctly coordinate structural, envelope, and MEP systems within realistic tolerances and code requirements [Usage] **III:** Evaluate a set of construction documents for assembly coordination quality, identifying conflicts, missing details, and buildability risks [Assessment]

Bibliography: [Allen and Iano, 2019]

5.3 BIM Fundamentals and Authoring, 5 hr(s)

Competences: AG-A09

Topics: **I:** Core BIM concepts: object-oriented modeling (walls, doors, windows with embedded data), parametric relationships (hosting, constraints), and the difference between BIM and conventional 2D/3D modeling **II:** BIM authoring tools: Revit (project-based, family editor), ArchiCAD (virtual building model), Vectorworks, and their respective modeling philosophies and interoperability **III:** Level of development (LOD) specification: LOD 100 (conceptual), 200 (schematic), 300 (detailed), 350 (construction-ready), 400 (fabrication), 500 (as-built) **IV:** Data exchange standards: Industry Foundation Classes (IFC) as openBIM exchange format, IFC schema (IfcWall, IfcDoor, IfcWindow, IfcSpace), and vendor-neutral model interoperability

Learning Outcomes **I:** Describe the core concepts of BIM: object-based modeling, parametric relationships, LOD, and data exchange via IFC, and explain how BIM differs from traditional 2D CAD [Familiarity] **II:** Develop a BIM model of a small building at LOD 200-300, producing plans, sections, elevations, and a simple schedule directly from the model, and export the model to IFC format [Usage] **III:** Evaluate a BIM model for appropriate LOD, correct parametric relationships, and clean IFC export, identifying modeling errors that would impede downstream coordination or data exchange [Assessment]

Bibliography: [Eastman et al., 2011]

5.4 BIM Execution Planning and Standards, 3 hr(s)

Competences: AG-A09

Topics: **I:** BIM Execution Plan (BEP): project goals for BIM use (clash detection, 4D/5D, facility management), LOD matrix by discipline, model sharing protocols **II:** ISO 19650 framework: information management using BIM across the delivery and operational phases of assets, information requirements (EIR, OIR, AIR), and the information-delivery cycle

Learning Outcomes **I:** Describe the purpose of a BIM Execution Plan and the ISO 19650 information-management framework, and explain how they structure a project's BIM deliverables [Familiarity] **II:** Draft a BIM Execution Plan for a project, specifying BIM goals, LOD matrix, and information-delivery milestones aligned with ISO 19650 [Usage] **III:** Evaluate a BIM Execution Plan for a design project, assessing its LOD specifications, exchange protocols, and BIM use cases for adequacy and clarity [Assessment]

Bibliography: [Eastman et al., 2011]

5.5 Energy Efficiency and Net-Zero Design, 10 hr(s)

Competences: AG-A13

Topics: **I:** Building energy modeling (BEM): physics-based simulation (EnergyPlus, eQUEST, IES VE), input parameters (envelope, lighting, HVAC, schedules, plug loads), **II:** Efficiency-first approach: envelope optimization (high R-value, low air leakage), high-performance glazing, efficient lighting (LED with controls), **III:** On-site renewable energy: photovoltaic (PV) array sizing (roof, facade, parking canopy), inverter selection, and estimating annual production (PVWatts, SAM) **IV:** Zero energy certification frameworks: NZEB (zero net energy building) definitions by DOE, Living Building Challenge Energy Petal, and Passive House Plus **V:** Deep energy retrofit for existing buildings: envelope upgrades (window replacement, exterior insulation), HVAC replacement with heat pumps, and lighting retrofit

Learning Outcomes **I:** Describe the components of a net-zero energy building design - load reduction, efficiency, and on-site renewables - [Familiarity] **II:** Perform a preliminary energy balance for a building design, calculating estimated EUI from a simple model and sizing a PV array to offset annual energy consumption [Usage] **III:** Evaluate a proposed net-zero building design by reviewing its energy model inputs and assumptions, identifying unrealistic plug load estimates or insufficient PV area, [Assessment]

Bibliography: [Kibert, 2016]

5.6 Building Codes, Accessibility, and Zoning, 8 hr(s)

Competences: AG-A12

Topics: **I:** Building codes and standards: IBC (International Building Code), IRC (International Residential Code), IFC (International Fire Code) **II:** Means-of-egress and fire-evacuation route design: maximum travel distance to an exit, number and width of exits required by occupant load, exit discharge and assembly points, and diagramming evacuation routes on a life-safety plan **III:** Accessibility codes: ADA Standards for Accessible Design, ICC A117.1, and local accessible building codes **IV:** Energy codes: IECC (International Energy Conservation Code), ASHRAE 90.1; prescriptive vs. performance paths **V:** Zoning and land use regulations: zoning districts (residential, commercial, industrial, mixed-use), floor area ratio (FAR), lot coverage, setbacks, height limits **VI:** Permitting process: building permit, variance, special exception; code interpretation appeals; the architect's role in preparing permit sets, responding to plan review comments

Learning Outcomes **I:** Describe the key provisions of building codes that affect architectural design - occupancy classification, means of egress, fire-resistance, accessibility, and energy performance [Familiarity] **II:** Apply IBC occupancy and construction type tables to determine allowable building area and height for a given use and sprinkler status, [Usage] **III:** Evaluate a building design's code compliance for accessibility (ADA) and life safety (IBC), identifying violations and recommending code-conforming modifications [Assessment]

Bibliography: [Ching and Winkel, 2017]

6. Bibliography

[Allen and Iano, 2019] Allen, E. and Iano, J. (2019). *Fundamentals of Building Construction: Materials and Methods*. Wiley, 7th edition.

[Ching and Winkel, 2017] Ching, F. D. K. and Winkel, S. R. (2017). *Building Codes Illustrated: A Guide to Understanding the International Building Code*. Wiley, 6th edition.

[Eastman et al., 2011] Eastman, C., Teicholz, P., Sacks, R., and Liston, K. (2011). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors*. Wiley, 2nd edition.

[Kibert, 2016] Kibert, C. J. (2016). *Sustainable Construction: Green Building Design and Delivery*. Wiley, 4th edition.

[Schierle, 2012] Schierle, G. G. (2012). *Architectural Structures*. University of Southern California.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR403 Research Work (Mandatory)

1. General information

- **Semester**: 10th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours;
- **Prerrequisites**:
  - AR402 Research Workshop (9th Sem-Pg. 186)

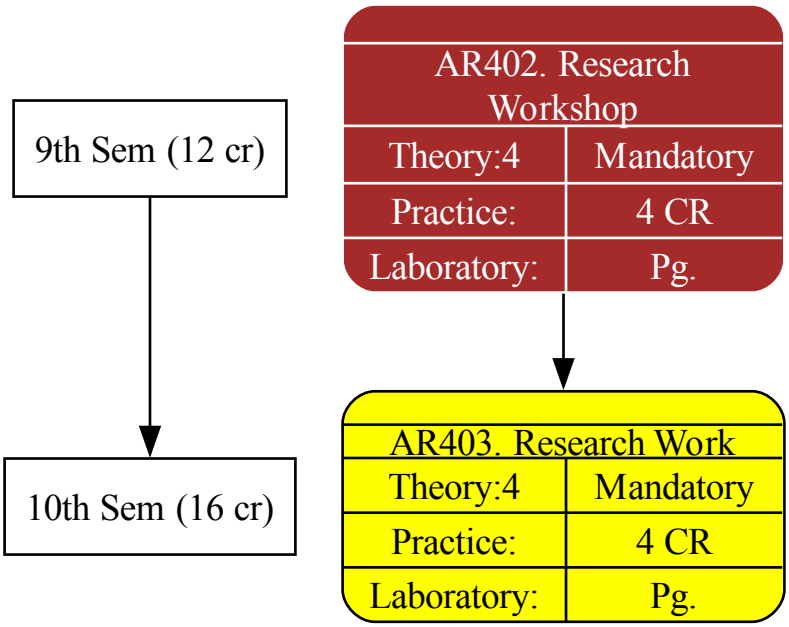


Figure 3.45: Connection Map. AR403 Research Work

2. Course Rationale

Research Work is the execution and defense phase of the research track, building directly on the approved proposal from Research Workshop (ARC402, prerequisite). Each student works under individualized advisor supervision to collect, process, and analyze data on a real territorial or urban problem, arriving at evidence-grounded conclusions that respond to the research questions formulated earlier in the sequence.

3. Goals of the Course

- That the student executes the research proposal approved in Research Workshop (ARC402), collecting and analyzing data on a real territorial problem.
- That the student arrives at evidence-based conclusions and formulates actionable recommendations for the territorial problem studied.
- The deliverables of this course are:

  Partial: Data collection, processing, and preliminary analysis against the approved consistency matrix.

Final: A complete research report (data analysis, discussion of results, conclusions, and recommendations), defended before an academic and professional jury.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A10) Conducts studies of complex problems using research methods, experimental design, data analysis, and information synthesis to reach valid conclusions. (Assessment)

5. Content

5.1 Data Collection, Analysis, and Discussion of Results, 48 hr(s)

Competences: AG-A04,AG-A10

Topics: I: Fieldwork and data collection according to the approved instruments (surveys, interviews, GIS/territorial data). **II:** Data processing, analysis, and triangulation (methodological, data, or investigator triangulation). **III:** Discussion of results against the theoretical framework and comparison with relevant prior studies.

Learning Outcomes I: Collect and process data according to the methods and instruments approved in the research proposal [Usage]. **II:** Analyze the collected data and discuss the results against the theoretical framework and prior literature [Assessment]. **III:** Formulate evidence-grounded conclusions and actionable recommendations for the territorial problem studied [Assessment].

Bibliography: [Booth et al., 2016, Yin, 2018]

5.2 Research Report and Defense, 32 hr(s)

Competences: AG-A04,AG-A10

Topics: I: Structure and academic writing conventions of a research report (introduction, methods, results, discussion, conclusions). **II:** Preparation and delivery of an oral defense before an academic and professional jury.

Learning Outcomes I: Write a complete research report following academic conventions, integrating conclusions and recommendations [Assessment]. **II:** Defend the research work before an academic and professional jury, responding to questions about methodology and findings [Assessment].

Bibliography: [Booth et al., 2016]

6. Bibliography

[Booth et al., 2016] Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., and FitzGerald, W. T. (2016). *The Craft of Research*. University of Chicago Press, 4th edition.

[Yin, 2018] Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods*. SAGE Publications, 6th edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR404 Innovation and Entrepreneurship (Mandatory)

1. General information

- **Semester**: 10^{th} Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours;
- **Prerrequisites**: None

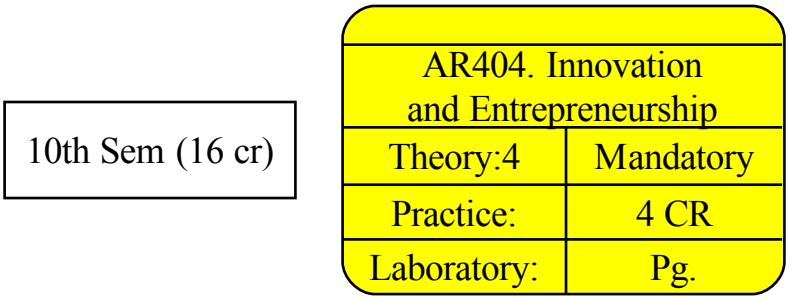


Figure 3.46: Connection Map. AR404 Innovation and Entrepreneurship

2. Course Rationale

Innovation and Entrepreneurship closes the specialization alongside Research Work (ARC403), giving students the professional-practice and real-estate-development toolkit – entrepreneurship models, project feasibility, PropTech, and participatory development – needed to turn a territorial or urban diagnosis into a viable, fundable initiative. It draws on Real Estate Development and Construction Economics (RED) and the entrepreneurship-specific unit of Professional Practice and Ethics (PRO), the two Arch2027 knowledge areas that cover the business side of the profession.

3. Goals of the Course

- Identify the professional and business dimension of practicing architecture and urbanism, including entrepreneurship models and firm structures.
- Assess the technical and financial feasibility of a territorial development initiative (market analysis, cost, financing).
- Evaluate digital/PropTech innovations applicable to real-estate and territorial-development processes.
- Design a participatory, stakeholder-engaged process for a territorial or urban innovation initiative.

4. General Competences (*Outcomes*)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Assessment)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Assessment)

5. Content

5.1 Business of Architecture and Entrepreneurship, 16 hr(s)

Competences: AG-A05

Topics: **I:** Architectural firm management: business structures (sole proprietorship, LLC, corporation), financial management (overhead, billable rates, utilization rate, profit margin), **II:** Fee structures and negotiation: hourly, percentage of construction cost, lump sum, and design-build fees; calculating multiplier and break-even rate **III:** Business development and marketing: identifying target project types, proposal writing, interview preparation, client relationship management (CRM), **IV:** Entrepreneurial architecture: product-based practice (design-build of prefab units, furniture, components), architect as developer, start-up models (co-working, remote practice) **V:** Intellectual property in architecture: copyright ownership of architectural works (US Copyright Act, Berne Convention), licensing of drawings and digital models, moral rights,

Learning Outcomes **I:** Identify the key financial metrics of architectural practice (utilization rate, multiplier, break-even rate) and describe common fee structures and their risks and benefits [Familiarity] **II:** Prepare a simple business plan for a hypothetical architectural firm, including target markets, fee strategy, staffing plan, and financial projections for the first three years [Usage] **III:** Evaluate a firm's financial performance using P&L statements, balance sheets, and KPI benchmarks from AIA or RIBA business surveys [Assessment]

Bibliography: [Osterwalder and Pigneur, 2010]

5.2 Development Process and Feasibility, 16 hr(s)

Competences: AG-A05

Topics: **I:** Development phases: site identification, option agreement, due diligence, entitlement (zoning, permits), design **II:** Due diligence for development sites: title review, environmental assessment (Phase I and II), geotechnical investigation, zoning analysis, utility availability, **III:** Entitlements and permitting: land use approvals (rezoning, variances, conditional use permits), building permits, impact fees (school, traffic, parks) **IV:** Feasibility study components: market support, site suitability, regulatory pathway, construction feasibility, financial pro forma (with sensitivity analysis), **V:** Real estate pro forma basics: projected net operating income (NOI = gross potential rent minus vacancy allowance minus operating expenses), debt service coverage ratio (DSCR),

Learning Outcomes **I:** Describe the major stages of the real estate development process - predevelopment, construction, lease-up, disposition - and the due diligence [Familiarity] **II:** Prepare a feasibility study for a proposed development, including market analysis, site due diligence summary, entitlement pathway, construction cost estimate, [Usage] **III:** Evaluate a development pro forma for financial viability, identifying understated risk (vacancy, construction contingency) [Assessment]

Bibliography: [Peiser and Hamilton, 2019]

5.3 PropTech and Digital Real Estate Innovation, 16 hr(s)

Competences: AG-A06

Topics: **I:** PropTech categories: marketing and leasing (listing platforms, CRM), asset and property management (tenant portals, maintenance platforms), data **II:** AI in real estate: automated valuation models (AVM), rent prediction models, tenant behavior analytics, and AI for site selection (site scoring, foot traffic analysis) **III:** Blockchain in real estate: tokenization of real estate assets (fractional ownership), smart contracts for lease **IV:** Smart building data for real estate: IoT sensor data (occupancy, energy, indoor environmental quality) used for performance-based leasing, predictive maintenance, **V:** Commercial real estate tech (CREtech):

online leasing platforms (VTS, Reonomy), virtual tours and 3D scanning, flex-space management software,

Learning Outcomes **I:** Describe the main categories of PropTech (marketing, management, analytics, investment, construction) and how they affect real estate development and operations [Familiarity] **II:** Propose a PropTech solution to a real estate development or management problem (e.g., lease-up velocity, tenant retention, valuation accuracy), specifying the data sources [Usage] **III:** Evaluate a PropTech startup or platform for its value to developers or investors, assessing its data accuracy, integration capabilities, regulatory compliance, [Assessment]

Bibliography: [Saull and Bayer, 2020]

5.4 Stakeholder and Participatory Development, 16 hr(s)

Competences: AG-A06

Topics: **I:** Levels of stakeholder participation in development: inform, consult, involve, collaborate, empower (Arnstein's ladder) **II:** Community benefits agreements (CBA): negotiating community benefits (local hiring, affordable housing, public space) in exchange for development approval, legal enforceability **III:** Stakeholder mapping and analysis: identifying interest, influence, and impact on the development; designing engagement strategies for supportive, neutral, **IV:** Inclusive development models: land trusts, cooperative housing, community land banks, and public-community partnerships that give residents a stake in development outcomes **V:** Participatory budgeting in development: allocating a portion of public infrastructure budget through community vote

Learning Outcomes **I:** Describe the levels of stakeholder participation in development and the mechanisms (CBA, participatory budgeting, land trust) for inclusive development [Familiarity] **II:** Develop a community engagement plan for a real estate development project, identifying stakeholders, choosing participation methods, [Usage] **III:** Evaluate a community benefits agreement or participatory process for representativeness, enforceability, and impact on equitable development outcomes [Assessment]

Bibliography: [Brown, 2009]

6. Bibliography

[Brown, 2009] Brown, T. (2009). *Change by Design*. Harper Business, 1st edition.

[Osterwalder and Pigneur, 2010] Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation*. Wiley, 1st edition.

[Peiser and Hamilton, 2019] Peiser, R. B. and Hamilton, D. (2019). *Professional Real Estate Development: The ULI Guide to the Business*. Urban Land Institute, 4th edition.

[Saull and Bayer, 2020] Saull, A. and Bayer, A. (2020). *The PropTech Guide*. self-published / Future PropTech, 1st edition.

Universidad Privada de Tacna (UPT)
Facultad de Arquitectura y Urbanismo
Escuela Profesional de Arquitectura

AR4B1 AI-Assisted Automation (Mandatory)

1. General information

- **Semester**: 10th Sem. **Credits**: 4
- **Hour of this course**: **Theory**: 4 hours; **Practice**: 4 hours;
- **Prerrequisites**:
  - AR3B4 Heritage and Infrastructure (9th Sem-Pg. 178)

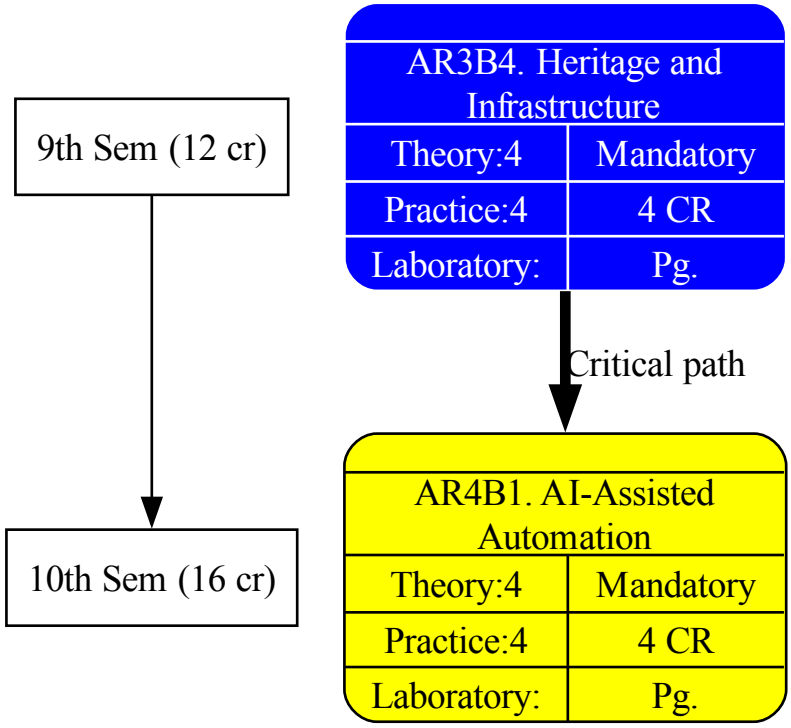


Figure 3.47: Connection Map. AR4B1 AI-Assisted Automation

2. Course Rationale

AI-Assisted Automation closes the ten-course required BIM I-X sequence (AR1B1 through AR4B1), building directly on the authoring, coordination, scheduling/cost, and facilities-management skills developed course by course across the line, and on Heritage and Infrastructure's (AR3B4) immediate prerequisite content. As the line's capstone, it shifts the focus from any single BIM workflow to the integration of all of them: students apply AI-assisted and scripted automation to real BIM tasks, deliver a single end-to-end project package against their own stated BIM Execution Plan, and critically evaluate the research and practice trends – urban-scale digital twins, blockchain-based model provenance, BIM-robotics convergence – that are extending BIM beyond its current established workflows. The recurring BIM Software Practicum unit closes the course, as it does every course in the line, with a certification-aligned, hands-on deliverable in the tool most relevant to this course's AI-automation focus.

3. Goals of the Course

- Automate repetitive BIM authoring, documentation, and code-compliance tasks using AI-assisted and scripted tools.
- Deliver an end-to-end integrated BIM project package – authoring, coordination, 4D/5D data, and FM handover – against a stated BIM Execution Plan.
- Evaluate emerging BIM research and practice trends (urban-scale digital twins, blockchain model provenance, BIM-robotics convergence) for their near-term professional relevance.
- Complete a certification-aligned software practicum, building a cumulative deliverable that demonstrates proficiency in the course's AI-automation tool focus.

4. General Competences (*Outcomes*)

AG-A04) Communicates effectively and inclusively with the architecture community and society through reports, design documentation, and presentations tailored to different audiences. (Assessment)

AG-A05) Applies management principles and economic decision-making, considering risk, as a team member or leader, to manage projects in multidisciplinary environments. (Assessment)

AG-A06) Recognizes the need to learn independently and continuously, adapt to new and emerging technologies, and apply critical thinking in the face of technological change. (Assessment)

AG-A07) Applies knowledge of mathematics, natural sciences, and information technology to architectural, urban, and interior design solutions. (Assessment)

5. Content

5.1 AI-Assisted BIM Automation, 24 hr(s)

Competences: AG-A06

Topics: **I:** AI-assisted BIM automation: generative design for structural and MEP routing, automated code compliance checking, NLP-based specification extraction **II:** BIM automation and scripting: automating repetitive tasks (door and window schedules, room data sheets), generative layout for bathrooms and parking **III:** AI-assisted code compliance checking: NLP for parsing building-code provisions, automated rule checking of BIM models against applicable codes

Learning Outcomes **I:** Describe how AI and scripted automation can generate, check, and optimize BIM content, and identify tasks that are good candidates for automation [Familiarity] **II:** Automate a repetitive BIM task (schedule generation, code-compliance check, or layout generation) using a scripted or AI-assisted tool [Usage] **III:** Evaluate an AI-assisted or scripted BIM automation tool for its accuracy, reliability, and actual time savings over manual methods [Assessment]

Bibliography: [del Campo and Manninger, 2022]

5.2 Integrated BIM Project Delivery (Capstone), 24 hr(s)

Competences: AG-A04,AG-A05

Topics: **I:** Integrating a project's full BIM workflow: authoring, federation and clash resolution, 4D/5D linkage, and FM-ready handover data, delivered as a single coherent package **II:** Executing a BIM Execution Plan end to end on a real project deliverable, tracking its stated BIM goals and LOD matrix against what was actually produced

Learning Outcomes **I:** Describe how a BIM Execution Plan's stated goals connect authoring, coordination, scheduling/cost, and FM handover into a single integrated project workflow [Familiarity] **II:** Deliver an integrated BIM project package covering authoring, coordination, 4D/5D data, and FM handover, following a stated BIM Execution Plan [Usage] **III:** Evaluate an integrated BIM project deliverable against its own BIM Execution Plan, judging completeness and internal consistency across authoring, coordination, and handover data [Assessment]

Bibliography: [Eastman et al., 2018]

5.3 Emerging Trends in BIM Practice, 24 hr(s)

Competences: AG-A06

Topics: **I:** Urban-scale digital twins combining building BIM, infrastructure BIM, and city-scale sensor networks for planning and resilience analysis **II:** Blockchain and distributed-ledger proposals for BIM model provenance, version authenticity, and smart contracts tied to model milestones **III:** Convergence of BIM with construction robotics and autonomous site monitoring, extending the AI-assisted automation already covered in BIM.AIAutomation

Learning Outcomes **I:** Describe two or three emerging research or practice directions that are extending BIM beyond its current established workflows [Familiarity] **II:** Discuss, with supporting evidence, the practical maturity and adoption barriers of one emerging BIM trend [Usage] **III:** Evaluate the likely near-term impact of an emerging BIM trend on professional practice in the student's own context [Assessment]

Bibliography: [Sawhney et al., 2020]

5.4 BIM Software Practicum, 24 hr(s)

Competences: AG-A07

Topics: **I:** Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable **II:** Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes **I:** Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity] **II:** Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage] **III:** Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Bibliography: [Davidson, 2015]

6. Bibliography

[Davidson, 2015] Davidson, S. (2015). *Grasshopper: Visual Scripting for Rhinoceros 3D*. self-published / McNeel, 1st edition.

[del Campo and Manninger, 2022] del Campo, M. and Manninger, S. (2022). *Neural Architecture: Design and Artificial Intelligence*. ORO Editions, 1st edition.

[Eastman et al., 2018] Eastman, C., Teicholz, P., Sacks, R., and Lee, G. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*. Wiley, 3rd edition.

[Sawhney et al., 2020] Sawhney, A., Riley, M., and Irizarry, J., editors (2020). *Construction 4.0: An Innovation Platform for the Built Environment*. Routledge, 1st edition.

Chapter 4

Professors & Courses

Taught courses by professor

There are no professors assigned in this document.

Professor assigned per course

- First Semester
  - AR1B1. Introduction to BIM (Pág 41)
    - There is no professor for this course
  - AR1D1. Design Studio I (Pág 45)
    - There is no professor for this course
  - AR1R1. Geometry and Analog Drawing (Pág 49)
    - There is no professor for this course
  - MA100. Basic Mathematics (Pág 52)
    - There is no professor for this course
  - MA111. Calculus I (Pág 54)
    - There is no professor for this course
  - EG163. Communication I (Pág 56)
    - There is no professor for this course
  - EG164. Digital Competencies Development (Pág 59)
    - There is no professor for this course
  - EG165. Strategies for Autonomous Learning (Pág 62)
    - There is no professor for this course
  - EG166. Basic Mathematics (Pág 65)
    - There is no professor for this course
- Second Semester
  - AR1B2. Parametric Modeling and Generative Design (Pág 68)
    - There is no professor for this course
  - AR1D2. Design Studio II (Pág 72)
    - There is no professor for this course
  - AR2R1. Digital Drafting (Pág 77)
    - There is no professor for this course
  - ID101. Technical and professional English I (Pág 80)
    - There is no professor for this course
  - EG263. Communication II (Pág 83)
    - There is no professor for this course
  - EG264. Philosophy (Pág 86)
    - There is no professor for this course
  - EG265. Peruvian Territory. National Defense and Security (Pág 89)
    - There is no professor for this course

- Third Semester
  - AR1D3. Design Studio III (Pág 92)
    - There is no professor for this course
  - AR2B1. Multidisciplinary Coordination (Pág 96)
    - There is no professor for this course
  - AR3R1. 3D Modeling and Virtual Animation (Pág 99)
    - There is no professor for this course
  - ID102. Technical and professional English II (Pág 103)
    - There is no professor for this course
  - EG364. Ethics (Pág 107)
    - There is no professor for this course
  - EG366. Personal Development and Leadership (Pág 110)
    - There is no professor for this course
- Fourth Semester
  - AR1T1. Digital Topography (Pág 113)
    - There is no professor for this course
  - AR2B2. BIM Execution Planning (Pág 116)
    - There is no professor for this course
  - AR2D1. Design Studio IV (Pág 119)
    - There is no professor for this course
  - ID201. Technical and professional English III (Pág 123)
    - There is no professor for this course
  - EG363. Ecology and Sustainable Development (Pág 127)
    - There is no professor for this course
  - EG365. Peru's Problems and Challenges in a Global World (Pág 130)
    - There is no professor for this course
- Fifth Semester
  - AR2B3. BIM Scheduling and Cost (Pág 133)
    - There is no professor for this course
  - AR2D2. Design Studio V (Pág 136)
    - There is no professor for this course
  - ID202. Technical and professional English IV (Pág 141)
    - There is no professor for this course
- Sixth Semester
  - AR2D3. Design Studio VI (Pág 145)
    - There is no professor for this course
  - AR3B1. Structural and MEP Coordination (Pág 149)
    - There is no professor for this course
  - ID203. Technical and professional English V (Pág 152)
    - There is no professor for this course
- Seventh Semester
  - AR3B2. Sustainability and Circular Economy (Pág 156)
    - There is no professor for this course
  - AR3D1. Design Studio VII (Pág 159)
    - There is no professor for this course
  - AR400. Scientific Research Methodology (Pág 163)
    - There is no professor for this course
- Eighth Semester
  - AR3B3. Facilities Management (Pág 167)
    - There is no professor for this course
  - AR3D2. Design Studio VIII (Pág 170)
    - There is no professor for this course
  - AR401. Statistics and Research Instruments (Pág 174)
    - There is no professor for this course
- Ninth Semester
  - AR3B4. Heritage and Infrastructure (Pág 178)

    - There is no professor for this course
  - AR3D3. Design Studio IX (Pág 182)
    - There is no professor for this course
  - AR402. Research Workshop (Pág 186)
    - There is no professor for this course
- Tenth Semester
  - AR3D4. Design Studio X (Pág 189)
    - There is no professor for this course
  - AR403. Research Work (Pág 194)
    - There is no professor for this course
  - AR404. Innovation and Entrepreneurship (Pág 196)
    - There is no professor for this course
  - AR4B1. AI-Assisted Automation (Pág 199)
    - There is no professor for this course

Chapter 5

Equivalences with Other Curriculum Plans

Below are the equivalences of this curriculum with the previous curriculum plan(s). For more details on the proposed curriculum, see section 2.2 (p. 10).

Chapter 6

Laboratories

Appendix A

Body of knowledge of General Architecture

The 15 knowledge areas in General Architecture are:

A.1 Architectural Design (ADG) (Pg.. 212)
- A.1.1 Foundations of Architectural Design (Pg.. 213)
- A.1.2 Visual and Plastic Arts Foundations (Pg.. 213)
- A.1.3 Design Process and Creative Methods (Pg.. 214)
- A.1.4 Performance-Driven Design (Pg.. 215)
- A.1.5 Human-Centered and Inclusive Design (Pg.. 215)
- A.1.6 Gender-Sensitive and Trauma-Informed Design (Pg.. 216)
- A.1.7 Computational and Generative Design (Pg.. 216)
- A.1.8 Tropical and Bioclimatic Design (Pg.. 217)
- A.1.9 Large-Scale and Complex Buildings (Pg.. 217)
- A.1.10 Design Research Methods (Pg.. 218)

A.2 History, Theory and Criticism (HTA) (Pg.. 218)
- A.2.1 World Architecture: Antiquity to the Middle Ages (Pg.. 218)
- A.2.2 Evolution of Peruvian Architecture (Pg.. 219)
- A.2.3 Modernism and the International Style (Pg.. 220)
- A.2.4 Latin American Architectural Traditions (Pg.. 220)
- A.2.5 Contemporary Architecture and Global Trends (Pg.. 221)
- A.2.6 Architectural Theory and Criticism (Pg.. 221)
- A.2.7 Decolonial and Postcolonial Perspectives (Pg.. 222)
- A.2.8 Vernacular and Indigenous Architecture (Pg.. 222)
- A.2.9 Futures Studies and Speculative Architectures (Pg.. 223)

A.3 Building Technology and Construction (BTC) (Pg.. 223)
- A.3.1 Building Systems and Assemblies (Pg.. 224)
- A.3.2 Facade and Building Envelope Technology (Pg.. 224)
- A.3.3 Conventional Construction Materials (Pg.. 225)
- A.3.4 Biobased and Mycelium Materials (Pg.. 225)
- A.3.5 Circular and Recycled Materials (Pg.. 226)
- A.3.6 Smart and Responsive Materials (Pg.. 226)
- A.3.7 Digital Fabrication and CNC Manufacturing (Pg.. 227)
- A.3.8 Robotic and Automated Construction (Pg.. 227)

A.4 Structural Systems for Architecture (STR) (Pg.. 228)
- A.4.1 Structural Principles and Mechanics (Pg.. 228)
- A.4.2 Vertical Load Path and Foundations (Pg.. 229)
- A.4.3 Residential and Vernacular Structural Systems (Pg.. 229)
- A.4.4 Lateral Load-Resisting Systems (Pg.. 230)
- A.4.5 Long-Span and Special Structures (Pg.. 230)
- A.4.6 Structural Morphology and Form-Finding (Pg.. 231)
- A.4.7 Computational Structural Analysis (Pg.. 231)
- A.4.8 Foundation and Geotechnical Considerations (Pg.. 232)
- A.4.9 Seismic Design for Architecture (Pg.. 232)
- A.4.10 AI-Assisted Structural Optimization (Pg.. 233)

A.5 Environmental Systems and Sustainability (ENV) (Pg.. 233)
- A.5.1 Daylighting and Visual Comfort (Pg.. 233)
- A.5.2 Thermal Comfort and Passive Systems (Pg.. 234)
- A.5.3 Natural Ventilation and Indoor Air Quality (Pg.. 234)
- A.5.4 Mechanical Systems (HVAC) (Pg.. 235)
- A.5.5 Building Automation and Smart Systems (Pg.. 235)
- A.5.6 Acoustics and Noise Control (Pg.. 236)
- A.5.7 Energy Efficiency and Net-Zero Design (Pg.. 236)
- A.5.8 Water, Sanitation, and Waste Systems (Pg.. 237)
- A.5.9 Regenerative and Circular Design (Pg.. 237)
- A.5.10 Climate Resilience and Adaptation (Pg.. 238)

A.6 Urban Design and Planning (UDP) (Pg.. 238)
- A.6.1 Urban Form and Morphology (Pg.. 239)
- A.6.2 Historical Urban Planning Theories (Pg.. 239)
- A.6.3 Contemporary Planning Methods and Theory (Pg.. 239)
- A.6.4 Urban Design at Multiple Scales (Pg.. 240)
- A.6.5 Housing and Residential Environments (Pg.. 240)
- A.6.6 Informal Settlements and Incremental Urbanization (Pg.. 241)
- A.6.7 Urban Data Science and GeoAI (Pg.. 241)
- A.6.8 Smart Cities and Urban Digital Twins (Pg.. 242)
- A.6.9 Landscape and Open Space Design (Pg.. 242)
- A.6.10 Social Equity and Inclusive Urbanism (Pg.. 243)

A.7 Professional Practice and Ethics (PRO) (Pg.. 243)
- A.7.1 Architecture as a Profession (Pg.. 243)
- A.7.2 Project Delivery Methods and Contracts (Pg.. 244)
- A.7.3 Project Management and Construction Economics (Pg.. 244)
- A.7.4 Collaborative and Interdisciplinary Practice (Pg.. 245)
- A.7.5 Ethics, Decolonial Practice, and Social Responsibility (Pg.. 245)
- A.7.6 Business of Architecture and Entrepreneurship (Pg.. 246)
- A.7.7 Future of the Profession: AI and New Roles (Pg.. 246)

A.8 Architectural Representation and Digital Tools (REP) (Pg.. 247)
- A.8.1 Orthographic Drawing and Conventions (Pg.. 247)
- A.8.2 Computer-Aided Drafting (CAD) (Pg.. 248)
- A.8.3 Graphic Symbols and Drafting Conventions (Pg.. 248)
- A.8.4 Three-Dimensional Modeling (Pg.. 249)
- A.8.5 Architectural Communication and Presentation (Pg.. 249)
- A.8.6 Parametric Design and Visual Programming (Pg.. 250)
- A.8.7 Simulation and Performance Analysis (Pg.. 250)
- A.8.8 Augmented, Virtual, and Mixed Reality (XR) (Pg.. 251)
- A.8.9 Generative AI for Architectural Design (Pg.. 251)
- A.8.10 Digital Fabrication Output and CNC Toolpaths

(Pg.. 252)
A.9 Interior Architecture and Space Design (INT) (Pg.. 252)
- A.9.1 Interior Space Planning and Programming (Pg.. 253)
- A.9.2 Materials, Finishes, and Specifications (Pg.. 253)
- A.9.3 Furniture, Equipment, and Ergonomics (Pg.. 254)
- A.9.4 Lighting Design (Pg.. 254)
- A.9.5 Acoustics in Interior Spaces (Pg.. 254)
- A.9.6 Universal Design and Accessibility (Pg.. 255)
- A.9.7 Healthcare and Specialized Interiors (Pg.. 255)
- A.9.8 Sustainable Interior Design (Pg.. 256)

A.10 Heritage Conservation and Restoration (HER) (Pg.. 256)
- A.10.1 Theory and Philosophy of Conservation (Pg.. 257)
- A.10.2 Historic Documentation and Digital Survey (Pg.. 257)
- A.10.3 Structural Assessment of Historic Buildings (Pg.. 258)
- A.10.4 Restoration and Consolidation Techniques (Pg.. 258)
- A.10.5 Adaptive Reuse and Building Transformation (Pg.. 259)
- A.10.6 Landscape and Urban Heritage (Pg.. 259)
- A.10.7 Intangible Heritage and Living Traditions (Pg.. 260)

A.11 Landscape Architecture (LAN) (Pg.. 260)
- A.11.1 Landscape Design Principles and Process (Pg.. 261)
- A.11.2 Plants, Ecology, and Ecosystem Services (Pg.. 261)
- A.11.3 Landform, Hydrology, and Grading (Pg.. 262)
- A.11.4 Landscape Materials and Construction (Pg.. 262)
- A.11.5 Urban Landscape and Green Infrastructure (Pg.. 263)
- A.11.6 Climate-Responsive Landscape Design (Pg.. 263)
- A.11.7 Ecological Restoration and Nature-Based Solutions (Pg.. 264)
- A.11.8 Landscape at Regional and Territorial Scale (Pg.. 264)

A.12 Real Estate Development and Construction Economics (RED) (Pg.. 264)
- A.12.1 Real Estate Market Analysis (Pg.. 265)
- A.12.2 Development Process and Feasibility (Pg.. 265)
- A.12.3 Construction Cost Estimation (Pg.. 266)
- A.12.4 Project Finance and Investment (Pg.. 266)
- A.12.5 Housing Policy and Affordable Development (Pg.. 267)
- A.12.6 Circular Economy and Adaptive Reuse Economics (Pg.. 267)
- A.12.7 Stakeholder and Participatory Development (Pg.. 268)
- A.12.8 PropTech and Digital Real Estate Innovation (Pg.. 268)

A.13 Research Methods and Emerging Technologies (RES) (Pg.. 269)
- A.13.1 Research Design and Methodologies (Pg.. 269)
- A.13.2 Quantitative Methods in Architectural Research (Pg.. 269)
- A.13.3 Qualitative and Ethnographic Methods (Pg.. 270)
- A.13.4 Evidence-Based Design (Pg.. 270)
- A.13.5 Neuroscience and Cognitive Approaches (Pg.. 271)
- A.13.6 AI and Machine Learning in Architectural Research (Pg.. 271)
- A.13.7 Speculative and Future-Oriented Research (Pg.. 272)
- A.13.8 IoT, Sensing, and Smart Building Research (Pg.. 272)
- A.13.9 Post-Occupancy Evaluation and Building Science (Pg.. 273)
- A.13.10 Theoretical Framework and Literature Review (Pg.. 273)
- A.13.11 Research Hypotheses and Variables (Pg.. 274)

A.14 Architectural Regulations and Standards (NRM) (Pg.. 274)
- A.14.1 Building Codes, Accessibility, and Zoning (Pg.. 275)
- A.14.2 Peruvian Regulatory Framework for Architectural Practice (Pg.. 275)

A.15 Building Information Modeling (BIM) (Pg.. 276)
- A.15.1 BIM Fundamentals and Authoring (Pg.. 277)
- A.15.2 Parametric Modeling and Visual Scripting for BIM (Pg.. 277)
- A.15.3 Multidisciplinary Model Coordination (Pg.. 278)
- A.15.4 4D BIM and Construction Scheduling (Pg.. 278)
- A.15.5 5D BIM and Cost Estimation (Pg.. 278)
- A.15.6 BIM for Structural and MEP Coordination (Pg.. 279)
- A.15.7 BIM for Sustainability Analysis (Pg.. 279)
- A.15.8 BIM for Facilities Management (Pg.. 279)
- A.15.9 BIM Execution Planning and Standards (Pg.. 280)
- A.15.10 Collaborative BIM Workflows (Pg.. 280)
- A.15.11 Heritage BIM (HBIM) (Pg.. 280)
- A.15.12 BIM for Infrastructure and Urban Modeling (Pg.. 281)
- A.15.13 AI-Assisted BIM Automation (Pg.. 281)
- A.15.14 BIM Standards, Policy, and Contracts (Pg.. 282)
- A.15.15 BIM-Based Construction Documentation (Pg.. 282)
- A.15.16 BIM Model Organization and Worksharing (Pg.. 283)
- A.15.17 Generative Design and Optioneering (Pg.. 283)
- A.15.18 Model-Based Issue and RFI Management (Pg.. 283)
- A.15.19 BIM Across Project Delivery Methods (Pg.. 284)
- A.15.20 Lean Construction and 4D BIM Integration (Pg.. 284)
- A.15.21 Fabrication-Level BIM Detailing (Pg.. 285)
- A.15.22 BIM Model Quality Control and Auditing (Pg.. 285)
- A.15.23 BIM for Circular Economy and Material Reuse (Pg.. 285)
- A.15.24 BIM-Supported Green Building Certification (Pg.. 286)
- A.15.25 Operational Digital Twins from BIM (Pg.. 286)
- A.15.26 Asset Classification and Data Standards for FM (Pg.. 287)
- A.15.27 Reality Capture for BIM: Point Clouds and Photogrammetry (Pg.. 287)
- A.15.28 Integrated BIM Project Delivery (Capstone) (Pg.. 287)
- A.15.29 Emerging Trends in BIM Practice (Pg.. 288)
- A.15.30 BIM Software Practicum (Pg.. 288)

A.1 Architectural Design (ADG)

Architectural Design is the central discipline of architectural education. It encompasses the theory, methods, and studio practice through which architects conceive, develop, and communicate spatial proposals across scales - from a single room to an urban block. This knowledge area integrates formal, functional, cultural, environmental, and technical considerations into coherent built proposals. It covers foundational design principles as well as contemporary approaches including performance-driven, computational, generative, bioclimatic, and community-centered design. Students develop the capacity to analyze problems, generate spatial proposals, evaluate alternatives, and defend design decisions with both rigor and creative ambition.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.1.1 Foundations of Architectural Design (Pg.. 213)	1	1
⭐ A.1.2 Visual and Plastic Arts Foundations (Pg.. 213)	1	1
⭐ A.1.3 Design Process and Creative Methods (Pg.. 214)	1	1
⭐ A.1.4 Performance-Driven Design (Pg.. 215)	1	1
⭐ A.1.5 Human-Centered and Inclusive Design (Pg.. 215)	1	1
A.1.6 Gender-Sensitive and Trauma-Informed Design (Pg.. 216)	Elective	
⭐ A.1.7 Computational and Generative Design (Pg.. 216)	1	1
⭐ A.1.8 Tropical and Bioclimatic Design (Pg.. 217)	1	1
A.1.9 Large-Scale and Complex Buildings (Pg.. 217)	Elective	
A.1.10 Design Research Methods (Pg.. 218)	Elective	

Table A.1: List of KUs in the Architectural Design area.

A.1.1 ADG/Foundations of Architectural Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the fundamental spatial, formal, and compositional concepts that underpin all architectural design: space, perception, materiality, form, light, program, site, and precedent study.

Topics:

Core

- Space, form, and order: positive and negative space, enclosure, threshold, spatial sequence, hierarchy, scale, and proportion as fundamental architectural design concepts
- Architectural elements and their spatial roles: wall, floor, ceiling, and roof as enclosure; column, beam, and slab as structure
- Composition and formal operations: symmetry, asymmetry, balance, rhythm, repetition, modulation, contrast, and tension as tools of architectural formal organization
- Light and shadow as design media: natural light quality by orientation and time, shadow and material surface perception, light as spatial modifier - compression, expansion, focus
- Embodied perception of space: scale as bodily experienced rather than drawn, movement and kinesthetic sequence through space, and the visual, acoustic, and tactile engagement that shapes how a space is actually inhabited and felt
- Materiality as an experiential design medium: texture, weight, surface finish, and color, and the atmosphere and character that material choice and craft give to a space, as distinct from a material's structural or technical properties
- Program and spatial organization: functional zoning and bubble diagrams, circulation systems (horizontal, vertical, service), spatial hierarchy, and programmatic sequence

Non Core

- Precedent study methods: formal analysis frameworks for canonical architectural works; reading plans, sections, and photographs as design intelligence

Learning Outcomes:

Core:

1. Identify and describe the key spatial, perceptual, material, and compositional concepts that constitute the foundations of architectural design [Familiarity]
2. Apply foundational design principles - space, perception, materiality, light, program, and composition - in the development of a spatial architectural proposal [Usage]
3. Evaluate a design or building project for the quality of its spatial organization, formal coherence, perceptual experience, material expression, and use of light and program, identifying strengths and areas for improvement [Assessment]

A.1.2 ADG/Visual and Plastic Arts Foundations (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the foundational visual-arts skills that underpin architectural design education: color theory, observational and artistic drawing, two-dimensional painting and composition, and three-dimensional

form studies through sculpture and modeling.
Topics:
Core

- Color theory: hue, value, and saturation; color wheel relationships (complementary, analogous, triadic, split-complementary); color psychology, cultural symbolism, and color's role in architectural and material composition
- Observational and artistic drawing: still-life and figure drawing, tonal value studies (shading, cross-hatching, chiaroscuro), proportion and gesture, as a visual-literacy complement to the measured, technical drawing of architectural representation
- Painting and two-dimensional composition: basic painting media and technique (watercolor, acrylic, gouache), and compositional principles - balance, focal point, visual weight, figure-ground - transferable to architectural and graphic composition
- Three-dimensional form studies and sculpture: additive and subtractive volume studies in clay, plaster, wire, or found materials, developing spatial and tactile sensibility as a precursor to architectural massing and model-making

Learning Outcomes:
Core:

1. Identify the fundamental principles of color theory, observational drawing, painting composition, and sculptural form, and describe their relevance to architectural design [Familiarity]
2. Apply color theory, observational drawing, and basic painting or sculptural techniques to produce a visual-arts study (drawing, painted composition, or volumetric form study) with technical and compositional competence [Usage]
3. Evaluate a visual-arts study for its use of color, composition, proportion, and form, and discuss how its principles could transfer to an architectural design problem [Assessment]

A.1.3 ADG/Design Process and Creative Methods (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the iterative design process from brief and site analysis to developed proposal, including design-criteria formulation, ideation (parti/concept development), diagramming, model-making, critique, and revision strategies.
Topics:
Core

- Brief analysis and problem framing: decomposing a design brief into spatial, functional, contextual, and performative requirements; identifying constraints and opportunities
- Architectural site analysis: solar orientation and sun path, prevailing wind and microclimate, topography and drainage, views and visual axes, vehicular and pedestrian access, surrounding urban fabric and context, and existing site constraints (easements, setbacks, utilities) as inputs to a design concept
- Design-criteria formulation: translating client and user requirements, site-analysis findings, and regulatory constraints into a prioritized, measurable set of functional, spatial, environmental, and budgetary criteria used to generate and evaluate design alternatives
- Ideation and concept development: sketching, diagramming, and collage as tools to explore spatial ideas; arriving at the parti (partido arquitectónico) – the single organizing idea that drives a design – and translating it into spatial and formal proposals
- Physical model-making as a design tool: study models for spatial exploration, massing studies, sectional models, and the role of making in discovering design solutions
- Iterative design and critique: pin-up and desk critique culture, receiving and integrating feedback, revision cycles, and developing design judgment through reflection
- Design narrative and argumentation: articulating design intent verbally and graphically, building a coherent design argument, and presenting spatial proposals persuasively

Non Core

- Collaborative and interdisciplinary design processes: co-design with engineers, landscape architects, and community stakeholders

Learning Outcomes:
Core:

1. Describe the stages of an iterative architectural design process, from brief and site analysis through design-criteria formulation, concept development (parti), revision, and final proposal [Familiarity]
2. Apply site analysis, design-criteria formulation, and systematic ideation and iterative critique methods to develop and refine a spatial architectural proposal in response to a design brief [Usage]
3. Evaluate the coherence and effectiveness of a design process, including the quality of concept articulation, iteration, and responsiveness to critique [Assessment]

A.1.4 ADG/Performance-Driven Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers design methods that integrate environmental, structural, and functional performance as generative drivers from the earliest stages of the design process.

Topics:

Core

- Integration of performance criteria into early design: using daylighting, solar access, thermal comfort, and structural efficiency as spatial
- Simulation-based design feedback: using tools such as Ladybug, Honeybee, and Grasshopper to evaluate energy, daylight,
- Passive design strategies: solar shading, natural ventilation, thermal mass, and orientation as architectural design elements that reduce mechanical energy loads
- Structural form-finding as design: integrating structural logic (arches, shells, trusses, tensile systems) into spatial and formal decisions from schematic design onward
- Building performance metrics and certification frameworks: EUI (energy use intensity), daylight autonomy, thermal comfort indices (PMV, SET),

Non Core

- AI-assisted performance optimization: generative adversarial networks and reinforcement learning for multi-objective design optimization

Learning Outcomes:

Core:

1. Identify the key environmental and structural performance criteria relevant to a design project and describe how they can inform early-stage spatial and formal decisions [Familiarity]
2. Apply passive design strategies and simulation feedback to develop a performance-informed architectural proposal that meets defined energy and comfort targets [Usage]
3. Evaluate a building design for environmental and structural performance using simulation outputs and standard metrics, and propose targeted design improvements [Assessment]

A.1.5 ADG/Human-Centered and Inclusive Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers design approaches that place human experience, equity, and accessibility at the center of architectural decision-making, from universal design to participatory methods.

Topics:

Core

- Universal design principles: equitable use, flexibility in use, simple and intuitive operation, perceptible information, tolerance for error, low physical effort, and size
- Accessibility standards and codes: ADA, ISO 21542, and regional building codes for accessible routes, ramps, elevators, restrooms, signage, and emergency egress
- Spatial user experience: wayfinding, legibility, sensory richness, acoustic comfort, and the design of spaces that support diverse activities, ages, and abilities
- Participatory design processes: engaging future users and communities in defining spatial needs; co-design workshops, interviews, and community mapping as design tools

Learning Outcomes:

Core:

1. Describe the principles of universal design and inclusive architecture and explain how they translate into spatial and technical design decisions [Familiarity]

2. Apply universal design principles and accessibility standards to develop an architectural design that accommodates the full spectrum of human ability, age, and cultural background [Usage]
3. Evaluate a building or public space design for inclusivity and accessibility, identifying barriers and proposing design modifications to improve equity and user experience [Assessment]

A.1.6 ADG/Gender-Sensitive and Trauma-Informed Design

Covers design approaches for gender, cultural, and trauma-related dimensions of human experience that extend beyond universal accessibility: gender-sensitive and culturally responsive design, and trauma-informed and neurodiverse design.

Topics:

Non Core

- Gender-sensitive and culturally responsive design: designing for diverse gender identities, cultural practices, and social norms; safety, privacy, and dignified space for all users
- Trauma-informed and neurodiverse design: spatial environments for mental health recovery, autism-spectrum users, and survivors of violence

Learning Outcomes:

NonCore:

1. Describe gender-sensitive, culturally responsive, and trauma-informed design approaches and explain the populations and experiences each is intended to serve [Familiarity]
2. Apply gender-sensitive or trauma-informed design principles to a specific population - such as survivors of violence or neurodiverse users - within an architectural design proposal [Usage]
3. Evaluate a building or public space design for its responsiveness to gender, cultural, or trauma-related user needs, identifying gaps and proposing design modifications [Assessment]

A.1.7 ADG/Computational and Generative Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers algorithmic, parametric, and AI-assisted design methods that expand the architect's capacity to generate, evaluate, and optimize complex spatial proposals.

Topics:

Core

- Parametric modeling fundamentals: defining geometry through relationships and constraints in tools such as Grasshopper/Rhino; rule-based variation and design families
- Algorithmic design methods: L-systems, cellular automata, space syntax analysis, and agent-based simulation as tools for generating spatial configurations
- Generative AI for design exploration: text-to-image diffusion models (Midjourney, Stable Diffusion, DALL-E) and multimodal AI (GPT-4V) for generating
- Multi-objective design optimization: Pareto-front analysis, evolutionary algorithms (Galapagos, Octopus),
- Data-driven design: using occupancy data, sensor data, and urban analytics to generate evidence-based spatial programs

Non Core

- Reinforcement learning for spatial layout: training RL agents to generate floor plans satisfying area, adjacency, and circulation constraints

Learning Outcomes:

Core:

1. Identify the main computational design methods - parametric, algorithmic, and AI-assisted - and describe their respective roles in the architectural design process [Familiarity]
2. Apply parametric modeling and generative design tools to produce and evaluate a set of design alternatives for an architectural project [Usage]

NonCore:

3. Evaluate the spatial and performance quality of computationally generated design proposals, selecting and refining the most promising candidate using design judgment [Assessment]

A.1.8 ADG/Tropical and Bioclimatic Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers architectural design strategies for tropical, equatorial, and hot-humid climates, integrating climate-responsive form, material, and landscape solutions for thermal and visual comfort.

Topics:

Core

- Tropical climate analysis: psychrometric charts, sun path diagrams, wind rose analysis, and bioclimatic chart interpretation for hot-humid, hot-dry, and composite tropical climates
- Bioclimatic building form: raised floors, deep overhangs, narrow floor plates, cross-ventilation layouts, lightweight roofs,
- Solar shading design: brise-soleil, louvers, screens, pergolas, and self-shading massing; calculating shading effectiveness by orientation, latitude, and season
- Vernacular tropical architecture: precedents from Southeast Asia, West Africa, Caribbean, and Latin America
- Landscape and vegetation as climate buffer: tree canopies for solar protection, evapotranspiration cooling, windbreaks, and green roofs in tropical contexts

Non Core

- Net-zero and near-zero energy design in tropical climates: photovoltaic integration, passive cooling combined with minimal mechanical cooling, and tropical Passivhaus adaptations

Learning Outcomes:

Core:

1. Describe the primary climatic challenges of tropical environments and identify the bioclimatic design strategies used to achieve thermal [Familiarity]
2. Apply bioclimatic design principles - shading, ventilation, form, and landscape - to develop an architectural proposal appropriate for a specific tropical or subtropical climate [Usage]
3. Evaluate a building design in a tropical context for climate responsiveness, identifying passive design deficiencies [Assessment]

A.1.9 ADG/Large-Scale and Complex Buildings

Covers design challenges specific to large, complex, and hybrid building typologies: mixed-use towers, healthcare facilities, airports, cultural institutions, and campus master plans.

Topics:

Non Core

- Programming and spatial organization at large scale: stacking diagrams, core-to-perimeter ratios, vertical circulation strategies,
- Life safety and means of egress in large buildings: occupancy-based egress design, pressurized stairwells, refuge floors, fire compartmentalization, and NFPA/IBC requirements
- Vertical transportation systems: elevator group design, sky lobbies, express/local zone strategies, escalators, and integration of vertical transport into building form
- Hybrid and mixed-use building design: separating and linking residential, commercial, hotel, and civic programs; transfer floors, podium strategies, and shared amenity programming
- Phased construction and building complexity: designing for construction staging, operational continuity, future expansion, and changeable use within long-lifespan complex buildings
- Campus and master plan design at large scale: site organization, wayfinding, public realm, phasing, infrastructure coordination, and identity across a multi-building ensemble

Learning Outcomes:

NonCore:

1. Identify the key design challenges - program complexity, life safety, vertical transport, and phasing - that distinguish large-scale buildings from smaller architectural projects [Familiarity]
2. Apply large-scale building design strategies to develop a spatial and programmatic organization for a complex multi-story or mixed-use building typology [Usage]
3. Evaluate a large-scale building design for programmatic coherence, life safety compliance, and operational efficiency [Assessment]

A.1.10 ADG/Design Research Methods

Covers the methods and frameworks for conducting research through, for, and about architectural design, including practice-based research, case study analysis, and evidence-based design.
Topics:
Non Core

- Research through design: using the design project itself as a research instrument; documenting, reflecting on, and theorizing the design process as a form of knowledge production
- Architectural case study methodology: selecting, documenting, and analyzing built projects as evidence; comparative case studies across typology, culture, or climate
- Evidence-based design: drawing on post-occupancy evaluation data, environmental psychology research, and user behavior studies to inform spatial and material design decisions
- Literature review and theoretical framing in architectural research: identifying relevant scholarship, positioning a design project within architectural discourse,
- Architectural criticism and evaluation frameworks: applying formal, phenomenological, typological, and sociocultural lenses to critically assess architectural works and proposals
- Dissemination of design research: writing architectural essays, preparing conference papers and journal submissions, and presenting design-research projects to academic

Learning Outcomes:
NonCore:

1. Describe the main modes of architectural design research - research through design, case study, and evidence-based design - and explain how each produces architectural knowledge [Familiarity]
2. Apply a design research methodology to frame, conduct, and document an investigation into an architectural design problem, producing a structured argument supported by evidence [Usage]
3. Critically evaluate an architectural design research project for the rigor of its methodology, the quality of its evidence, [Assessment]

A.2 History, Theory and Criticism (HTA)

History, Theory and Criticism provides architects with the intellectual frameworks to understand, situate, and critically evaluate architecture across time, cultures, and geographies. This knowledge area covers the history of the built environment from antiquity to the present, with particular attention to Latin American, vernacular, decolonial, and indigenous traditions alongside canonical Western narratives. It equips students with the theoretical tools of criticism - from formal analysis to postcolonial and feminist theory - and introduces speculative and futures-oriented perspectives that help architects engage creatively and critically with contemporary challenges.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.2.1 World Architecture: Antiquity to the Middle Ages (Pg.. 218)	1	1
⭐ A.2.2 Evolution of Peruvian Architecture (Pg.. 219)	1	1
⭐ A.2.3 Modernism and the International Style (Pg.. 220)	1	1
⭐ A.2.4 Latin American Architectural Traditions (Pg.. 220)	1	1
⭐ A.2.5 Contemporary Architecture and Global Trends (Pg.. 221)	1	1
⭐ A.2.6 Architectural Theory and Criticism (Pg.. 221)	1	1
⭐ A.2.7 Decolonial and Postcolonial Perspectives (Pg.. 222)	1	1
A.2.8 Vernacular and Indigenous Architecture (Pg.. 222)	Elective	
A.2.9 Futures Studies and Speculative Architectures (Pg.. 223)	Elective	

Table A.2: List of KUs in the History, Theory and Criticism area.

A.2.1 HTA/World Architecture: Antiquity to the Middle Ages (Core Tier1: 1 hr, Core Tier2: 1 hr)

Traces the evolution of architecture and its styles across the ancient and medieval world, from Mesopotamia and Egypt through Greece and Rome to the Byzantine, Islamic, and medieval European traditions.

Topics:
Core

- Mesopotamian and Egyptian architecture: the massive mudbrick ziggurat style and the trabeated, hypostyle temple style with canonical proportion systems; monumental construction and the social, religious, and cosmological dimensions of early built form
- Greek and Roman architecture: the classical orders (Doric, Ionic, Corinthian) as a stylistic vocabulary, civic typologies (agora, forum, basilica, amphitheater), and the Roman stylistic shift toward arcuated construction (arch, vault, dome)
- Early Christian, Byzantine, and Islamic architecture: the ornamental Byzantine style of mosaic-lined centralized domes (Hagia Sophia), basilica plan evolution, and the contemporaneous geometric and calligraphic style of Islamic ornament and mosque typology
- Medieval architecture in Europe: the stylistic shift from the massive, round-arched Romanesque style to the soaring, pointed-arch Gothic style (flying buttress, ribbed vault, stained glass), and the cathedral as the era's defining stylistic and urban monument

Learning Outcomes:
Core:

1. Identify the major architectural traditions, styles, and stylistic trends of the ancient and medieval world and describe their defining spatial, structural, and cultural characteristics [Familiarity]
2. Apply knowledge of ancient and medieval architectural styles and precedents to inform formal, spatial, or cultural decisions in a contemporary design project [Usage]
3. Critically analyze a historic building from the ancient or medieval world, situating it within its stylistic tradition using formal analysis, contextual interpretation, and cultural significance criteria [Assessment]

A.2.2 HTA/Evolution of Peruvian Architecture (Core Tier1: 1 hr, Core Tier2: 1 hr)

Traces the evolution of architecture and its styles in Peru, from the earliest monumental centers of the Andes through the regional and imperial pre-Hispanic states to the architectural syncretism of the early colonial period.

Topics:
Core

- Earliest monumental architecture of the Andes: Caral-Supe, the oldest urban civilization in the Americas, and the Chavín style's zoomorphic feline and raptor relief iconography at Chavín de Huántar's ceremonial complex, sunken plazas, and underground galleries
- Regional pre-Hispanic styles and trends: Moche platform-mound architecture with its narrative polychrome mural style (Huaca del Sol and de la Luna), Nazca ceremonial and settlement patterns, and the megalithic ashlar style and iconographic relief carving of Tiwanaku-Wari monumental stonework
- Chimú urbanism and Chan Chan: the Chimú style's repeating geometric and zoomorphic adobe-relief friezes, rammed-earth (tapia) citadel planning, ciudadela compounds, and hydraulic infrastructure on Peru's north coast
- Inca imperial architecture: the Inca style of precision-fitted ashlar and polygonal masonry and trapezoidal openings, Cusco's urban planning, Machu Picchu and Sacsayhuamán, agricultural terracing (andenes), and the Qhapaq Ñan road system

Non Core

- Early colonial syncretism in Peru: the transformation of Inca Cusco (Qorikancha into the Santo Domingo convent), Lima's historic center, and the sillar mestizo baroque style of Arequipa

Learning Outcomes:
Core:

1. Identify the major periods, civilizations, and stylistic trends in the evolution of Peruvian architecture, from the earliest Andean monumental centers to the Inca empire, and describe their defining spatial, structural, and cultural characteristics [Familiarity]
2. Apply knowledge of Peru's pre-Hispanic architectural styles and precedents - site planning, masonry, terracing - to inform formal, spatial, or cultural decisions in a contemporary design project [Usage]

3. Critically analyze a Peruvian archaeological or early colonial site, situating it within its stylistic tradition using formal analysis, contextual interpretation, and cultural significance criteria [Assessment]

A.2.3 HTA/Modernism and the International Style (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the emergence of modern architecture from the late 19th century through the mid-20th century, including the pioneers, the International Style, and postwar modernism.

Topics:

Core

- Pioneers of modern architecture: Sullivan's ornament and functionalism, Wright's organic architecture, Loos's ornament critique, and the Arts and Crafts
- European avant-garde and the Bauhaus: De Stijl (Mondrian, Rietveld), Constructivism (Tatlin, Melnikov), Expressionism (Mendelsohn), and the Bauhaus synthesis of art, craft,
- The International Style: Le Corbusier's five points, Mies van der Rohe's universal space and skin-and-bones aesthetic, Gropius and the rational dwelling
- Postwar modernism and its variants: Team 10 critique of CIAM, brutalism (Smithsons, Rudolph), metabolism (Tange, Kurokawa),
- Postmodernism and its critiques of modernism: Venturi's complexity and contradiction, Jencks's death of modern architecture, historicism, and the return of ornament

Non Core

- Late modernism and high-tech architecture: Rogers, Piano, and Foster; structural expressionism, transparency,

Learning Outcomes:

Core:

1. Describe the key movements, figures, and ideas of modern architecture from its emergence in the late 19th century through postmodernism [Familiarity]
2. Apply concepts and formal strategies drawn from modernism and its critiques to situate and inform a contemporary design project within architectural history [Usage]
3. Critically evaluate a 20th-century building using historical and theoretical frameworks, analyzing its relationship to the dominant architectural discourse of its period [Assessment]

A.2.4 HTA/Latin American Architectural Traditions (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the development of architecture in Latin America from the colonial period to the present, including modern movements, regional identities, and contemporary practice.

Topics:

Core

- Colonial baroque and mestizo architecture in Latin America: Churrigueresque ornament, Andean mestizo baroque (Arequipa, Potosí), Jesuit missions, and the synthesis of European
- Latin American modernism: Lúcio Costa and Oscar Niemeyer (Brasília), Carlos Raúl Villanueva (Ciudad Universitaria, Caracas), Juan O'Gorman, and Mario Pani in Mexico
- Critical regionalism in Latin America: Rogelio Salmona (Colombia), Eladio Dieste (Uruguay), Amancio Williams (Argentina), and the integration of climate, landscape,
- Lina Bo Bardi and Brazilian identity: MASP, SESC Pompéia, and the concept of popular culture as architectural source
- Contemporary architecture in Latin America: Elemental (Aravena), Smiljan Radic, Felipe Assadi, Solano Benítez, and Al Borde

Non Core

- Informal and self-built environments as architectural heritage: favela construction logics, incremental housing,

Learning Outcomes:

Core:

1. Identify the major periods, figures, and movements in Latin American architectural history from the colonial baroque to the contemporary period [Familiarity]
2. Apply knowledge of Latin American architectural traditions - critical regionalism, social engagement, [Usage]
3. Critically analyze a Latin American building of the 20th or 21st century, assessing its relationship to regional identity, climate, social context, [Assessment]

A.2.5 HTA/Contemporary Architecture and Global Trends (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the major tendencies in architecture from the 1990s to the present: digital turn, parametric formalism, sustainability, social engagement, and the emergence of AI-assisted design.

Topics:

Core

- The digital turn in architecture: the impact of CAD, BIM, and parametric design on form-making and fabrication
- The sustainability movement in contemporary architecture: green building certification systems, passive house adoption, net-zero targets,
- Social engagement and participatory architecture: Housing as Urbanism (Aravena/Elemental), community-led design in informal settlements, humanitarian architecture,
- Circular economy and material reuse in contemporary architecture: adaptive reuse as the dominant paradigm, material passports,
- AI in contemporary architectural practice: text-to-image tools (Midjourney, DALL-E) in design exploration, AI-assisted planning approval,

Non Core

- Architecture of the Global South: challenging Eurocentric narratives; African urbanism (NLé, Kéré Architecture), South and Southeast Asian practice,

Learning Outcomes:

Core:

1. Describe the major tendencies in contemporary global architecture - digital formalism, sustainability, social engagement, and AI - and identify key buildings [Familiarity]
2. Apply an understanding of contemporary architectural tendencies to position and argue for a design proposal within current disciplinary discourse [Usage]
3. Critically evaluate a recent building or design project in relation to the dominant tendencies of contemporary architecture, identifying its intellectual positioning [Assessment]

A.2.6 HTA/Architectural Theory and Criticism (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the major theoretical frameworks used to interpret, criticize, and produce architectural knowledge: formalism, phenomenology, semiotics, critical theory, and tectonics.

Topics:

Core

- Formalist theory: Colin Rowe's formal analysis, Peter Eisenman's syntactic autonomy, and the investigation of architecture's internal formal logic independent of social or
- Phenomenology of architecture: Heidegger's building-dwelling-thinking, Merleau-Ponty's embodied perception, Pallasmaa's haptic space,
- Semiotics and representation: architecture as language (Venturi, Jencks), the sign in architecture, postmodern historicism,
- Critical theory and architecture: Frankfurt School influences (Adorno, Habermas), Tschumi's deconstruction, Libeskind's trauma architecture,
- Tectonic theory: Frampton's studies in tectonic culture, the distinction between the structural and the scenographic,

Non Core

- Architectural writing and criticism: the architectural essay, manifesto, and review as genres; how critics (Banham, Frampton, Zaera-Polo) shape professional

Learning Outcomes:
Core:

1. Identify the major theoretical frameworks - formalism, phenomenology, semiotics, critical theory, and tectonics - and describe how each approaches the interpretation [Familiarity]
2. Apply a theoretical framework to analyze and argue for a specific architectural design approach, demonstrating the relevance of theory to design decision-making [Usage]
3. Critically evaluate an architectural work or design manifesto using multiple theoretical lenses, identifying the strengths and limitations of each interpretive framework [Assessment]

A.2.7 HTA/Decolonial and Postcolonial Perspectives (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the critical examination of colonial legacies in architecture and urban planning, and the decolonial frameworks that challenge Eurocentric canons and practices.
Topics:
Core

- Colonial urbanism and spatial violence: grid plans, racial zoning, and the built enforcement of colonial hierarchies in African, Asian,
- Critique of the architectural canon: challenging Eurocentric histories of architecture; recovering non-Western building traditions
- Decolonial architectural practice: recentering indigenous knowledge, community-led design, land stewardship, and relational approaches to architecture in postcolonial contexts
- African and Afro-diasporic architecture: vernacular traditions, contemporary African practice (Kéré, NLé, Adaye), and the spatial dimensions of the African diaspora in the Americas
- Gender, race, and architecture: feminist critiques of space (Matrix Feminist Design Co-op, bell hooks on homeplace), the politics of representation in architectural culture,

Non Core

- Epistemic justice in architectural education: decolonizing curricula, pluriversal design knowledge, and the role of architectural schools in reproducing or challenging colonial

Learning Outcomes:
Core:

1. Describe the main decolonial and postcolonial critiques of architecture and urban planning and identify the colonial spatial legacies that shape contemporary cities in the Global [Familiarity]
2. Apply decolonial frameworks to reinterpret a built environment, identifying colonial spatial logics and proposing alternative readings or design responses grounded in local [Usage]
3. Critically evaluate an architectural history curriculum, built environment policy, or design project for its implicit colonial assumptions [Assessment]

A.2.8 HTA/Vernacular and Indigenous Architecture

Covers the study of traditional, non-designed built environments as repositories of climate wisdom, cultural meaning, and sustainable construction knowledge.
Topics:
Non Core

- Defining vernacular architecture: the spectrum from anonymous building to pattern languages; Rapoport's socio-cultural model, Rudofsky's critique of the high-design canon,
- Climatic wisdom in vernacular architecture: earthen construction in arid climates (adobe, rammed earth), raised houses in humid tropics, snow architecture in arctic zones,
- Indigenous building traditions in the Americas: quechua kallanka and kancha, Amazon communal longhouses, Maya thatched structures,
- Pattern language and vernacular design intelligence: Alexander's pattern language as a method of encoding vernacular spatial wisdom
- Vernacular construction and climate resilience: lessons from traditional building for post-disaster reconstruction, local material use, self-build capacity,
- Contemporary architects engaging vernacular traditions: Diébédo Francis Kéré (earthen architecture), Balkrishna Doshi (courtyard housing),

Learning Outcomes:
NonCore:

1. Identify major vernacular and indigenous building traditions and describe the climatic, cultural, and social logics that shaped their spatial and material characteristics [Familiarity]
2. Apply insights from vernacular architecture - climatic strategies, spatial patterns, or material logic - to inform a contemporary design project in a culturally [Usage]
3. Critically assess how a contemporary architect has engaged vernacular or indigenous building traditions, evaluating the depth, authenticity, [Assessment]

A.2.9 HTA/Futures Studies and Speculative Architectures

Covers the use of speculative, scenario-based, and critical design methods to imagine radical architectural futures in response to climate change, urbanization, and technological transformation.
Topics:
Non Core

- Speculative and critical design: Dunne and Raby's framework; design as a tool for questioning assumptions, exploring possible futures,
- Architectural futures under climate change: sea level rise urbanism, underground cities, atmospheric urbanism, forest cities,
- AI and automation futures for architecture: the fully automated design office, AI as design agent, post-human authorship,
- Space architecture and off-world habitation: NASA and ESA habitat design research, lunar and Martian construction strategies, life-support systems integration,
- Utopian and heterotopian spatial imagination: Foucault's heterotopia, architectural utopias from Fourier's phalanstère to Archigram's Plug-In City
- Scenario-based design methods: constructing plausible future scenarios (2050, 2100) as design briefs; backcasting from desired futures to present-day design decisions

Learning Outcomes:
NonCore:

1. Describe the methods and frameworks used in speculative architecture and futures studies and identify key practitioners and projects that exemplify the genre [Familiarity]
2. Apply speculative design methods to develop an architectural scenario responding to a defined future condition - climate, technological [Usage]
3. Critically evaluate a speculative architectural project for the coherence of its future scenario, the quality of its spatial imagination, [Assessment]

A.3 Building Technology and Construction (BTC)

Building Technology and Construction covers the technical knowledge required to design and specify buildings that can be physically realized - from the assembly logic of conventional construction to emerging digital fabrication, robotic construction, and bio-based material innovations. This knowledge area bridges architectural design intent and physical execution, covering building systems, envelope technology, and conventional and advanced materials. Students learn to make informed decisions about construction methods, material specifications, and fabrication workflows that affect cost, performance, sustainability, and buildability. Construction-stage BIM coordination, scheduling, and cost estimation are covered in depth in the dedicated BIM knowledge area (see Multidisciplinary Model Coordination, 4D BIM and Construction Scheduling, 5D BIM and Cost Estimation).

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.3.1 Building Systems and Assemblies (Pg.. 224)	1	1
⭐ A.3.2 Facade and Building Envelope Technology (Pg.. 224)	1	1
⭐ A.3.3 Conventional Construction Materials (Pg.. 225)	1	1
⭐ A.3.4 Biobased and Mycelium Materials (Pg.. 225)	1	1
⭐ A.3.5 Circular and Recycled Materials (Pg.. 226)	1	1
⭐ A.3.6 Smart and Responsive Materials (Pg.. 226)	1	1
⭐ A.3.7 Digital Fabrication and CNC Manufacturing (Pg.. 227)	1	1
A.3.8 Robotic and Automated Construction (Pg.. 227)	Elective	

Table A.3: List of KUs in the Building Technology and Construction area.

A.3.1 BTC/Building Systems and Assemblies (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the integration of structural, envelope, mechanical, electrical, and interior systems into a coherent building assembly, including coordination, tolerances, and constructability.

Topics:

Core

- Integration of building systems: coordinating structural frame, mechanical/electrical/plumbing (MEP), envelope, and interior fit-out within constrained floor-to-floor heights
- Construction documentation for assemblies: details at 1:5, 1:10, and 1:20; section-through-wall details, sill and head conditions, and coordination between architectural
- Construction tolerances and coordination: dimensional tolerances in concrete, steel, and masonry; clearances for MEP rough-in
- Waterproofing and moisture management: below-grade waterproofing systems, drainage planes, vapor barriers, and flashing at penetrations
- Fire-rated assemblies: UL-listed wall, floor, and ceiling assemblies; fire-stopping at penetrations, intumescent seals, and the architectural detailing required by fire codes

Non Core

- Prefabricated and modular assemblies: volumetric modular construction, panelized wall systems, and the design implications of off-site manufacturing tolerances

Learning Outcomes:

Core:

1. Identify the principal building systems and describe how they are integrated and coordinated within a multi-story building assembly [Familiarity]
2. Develop construction-level details for a building assembly that correctly coordinate structural, envelope, and MEP systems within realistic tolerances and code requirements [Usage]
3. Evaluate a set of construction documents for assembly coordination quality, identifying conflicts, missing details, and buildability risks [Assessment]

A.3.2 BTC/Facade and Building Envelope Technology (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design and specification of high-performance building envelopes: opaque walls, glazing systems, curtain walls, and dynamic and responsive facade technologies.

Topics:

Core

- Envelope performance criteria: thermal transmittance (U-value), solar heat gain coefficient (SHGC), air infiltration, acoustic transmission loss,
- Glazing systems: double and triple glazing, low-e coatings, electrochromic and thermochromic glass, structural silicone glazing, and point-fixed glazing
- Curtain wall and rainscreen systems: pressure-equalized rainscreen principle, back-ventilated facades, unitized curtain wall panels, and the detailing of movement joints
- Insulation and airtightness: continuous insulation strategies for thermal bridge elimination, air barrier systems, blower-door testing, and Passivhaus envelope standards

- Opaque wall systems: masonry veneer, EIFS, precast concrete panels, metal panels, and fiber cement; fire rating, moisture management, and structural attachment for each system

Non Core

- Responsive and dynamic facade systems: kinetic facades (louvered, origami, pneumatic), electrochromic and BIPV panels, and media facades

Learning Outcomes:

Core:

1. Describe the main types of building envelope systems and their performance characteristics, including thermal, moisture, acoustic, and solar control properties [Familiarity]
2. Select and detail an appropriate building envelope system for a specific climate and building program, justifying the choice in terms of performance, cost, and constructability [Usage]
3. Evaluate a facade design for thermal, moisture, and solar performance, identifying deficiencies in detailing and proposing improvements to meet defined performance targets [Assessment]

A.3.3 BTC/Conventional Construction Materials (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the properties, structural behavior, and architectural applications of the primary conventional construction materials: concrete, steel, timber, and masonry.

Topics:

Core

- Concrete properties and types: compressive strength, workability, durability; reinforced concrete (RC), post-tensioned (PT), precast, and ultra-high-performance concrete (UHPC)
- Structural steel properties: yield strength, ductility, weldability; rolled sections (W, HSS, angle, channel), bolted and welded connections, and corrosion protection systems
- Timber properties and engineered wood products: sawn lumber, glulam, cross-laminated timber (CLT), LVL, and nail-laminated timber (NLT)
- Masonry properties and systems: clay brick, concrete masonry unit (CMU), natural stone, and adobe; compressive strength, bond patterns, mortar types, reinforced masonry,
- Material selection criteria: structural performance, thermal properties, durability, embodied carbon, cost, local availability,

Non Core

- Hybrid material systems: concrete-steel composites, timber-concrete composites, CLT-steel hybrids; connection design, differential movement,

Learning Outcomes:

Core:

1. Identify the principal conventional construction materials - concrete, steel, timber, and masonry - and describe their key structural, thermal, and durability properties [Familiarity]
2. Select and specify appropriate conventional construction materials for a building project, justifying the choice in terms of structural requirements, climate, embodied carbon, [Usage]
3. Evaluate the material specification of a building project for structural appropriateness, environmental performance, [Assessment]

A.3.4 BTC/Biobased and Mycelium Materials (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers emerging biobased construction materials - hemp, bamboo, mycelium composites, earthen systems - and their structural, environmental, and architectural applications.

Topics:

Core

- Bamboo construction: structural properties (tensile and compressive strength comparable to steel by weight), joinery systems, treatment against insects and moisture,
- Earthen construction: adobe, rammed earth (pisé), compressed earth blocks (CEB), and cob; thermal mass properties, moisture vulnerability, structural limitations,
- Hemp-lime (hempcrete) construction: mix design, formwork, curing, and hygrothermal performance; carbon sequestration during hemp growth

- Mycelium composite materials: growth substrate preparation, molding, heat-killing, and mechanical properties
- Life cycle assessment of biobased materials: embodied carbon, biogenic carbon sequestration, end-of-life compostability,

Non Core

- Frontier biobased research: bacterial self-healing concrete, algae-based facade panels, wood-derived transparent materials,

Learning Outcomes:

Core:

1. Describe the key biobased construction materials - bamboo, earthen systems, hemp-lime, and mycelium composites - and their structural, environmental, and architectural properties [Familiarity]
2. Select and specify an appropriate biobased material system for a construction project, integrating it with conventional structural elements [Usage]

NonCore:

3. Evaluate the lifecycle environmental performance of a biobased material specification, quantifying embodied carbon, biogenic sequestration, [Assessment]

A.3.5 BTC/Circular and Recycled Materials (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers circular economy principles applied to construction: material reuse, recycled content specifications, design for disassembly, and material passport frameworks.

Topics:

Core

- Circular economy in construction: the hierarchy of reuse (refurbish, repurpose, recycle, recover); Ellen MacArthur Foundation framework applied to building materials and components
- Design for disassembly: reversible connections (bolted vs. welded, dry vs. wet joints), accessible fasteners, standardized component dimensions,
- Material passports and digital product declarations: documenting material composition, structural properties, and reuse potential
- Recycled content specifications: recycled steel (EAF vs. BF), recycled concrete aggregate (RCA), reclaimed timber,
- Adaptive reuse technical assessment: structural capacity evaluation of existing buildings, floor-to-floor height compatibility for new uses, facade retention feasibility,

Non Core

- Urban mining and deconstruction: selective demolition methodologies, material recovery rates, contamination testing,

Learning Outcomes:

Core:

1. Describe the principles of circular construction, including design for disassembly, material passports, and recycled content specification, [Familiarity]
2. Apply circular economy principles to a building design, specifying recycled and reclaimed materials and designing connections and assemblies that support future disassembly [Usage]
3. Evaluate a building design or renovation project for circular economy compliance, scoring it against a material passport framework [Assessment]

A.3.6 BTC/Smart and Responsive Materials (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers materials with programmable or adaptive properties - shape memory alloys, phase-change materials, thermochromic coatings - and their integration into building envelopes and structures.

Topics:

Core

- Phase-change materials (PCMs) in construction: paraffin-based and salt-hydrate PCMs embedded in wallboards, concrete, and facades
- Shape-memory alloys (SMAs) in architecture: nitinol actuators for adaptive shading, self-deploying structures, and vibration damping

- Thermochromic and photochromic coatings: color and transmittance change as a function of temperature or UV exposure
- Self-healing construction materials: bacterial concrete (Bacillus pseudofirmus), encapsulated healing agents in polymer composites, and the potential for reduced maintenance
- Building-integrated photovoltaics (BIPV): crystalline silicon, thin-film, and perovskite solar cells integrated into roof, facade, and glazing elements

Non Core

- Soft robotics in facade systems: pneumatically actuated polymer facades for solar tracking, natural ventilation control, and dynamic shading

Learning Outcomes:

Core:

1. Identify the principal categories of smart and responsive materials - PCMs, SMAs, chromic coatings, BIPV - [Familiarity]
2. Select and integrate an appropriate smart material or responsive system into a building envelope or structure, justifying the choice in terms of performance benefit, cost, [Usage]

NonCore:

3. Evaluate a smart material system proposed for a building application, assessing its technical maturity, lifecycle performance, maintenance requirements, [Assessment]

A.3.7 BTC/Digital Fabrication and CNC Manufacturing (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of computer-controlled fabrication technologies in architecture: CNC milling, laser cutting, 3D printing, and robotic assembly - from prototype to full-scale construction.

Topics:

Core

- CNC and additive manufacturing fundamentals: G-code generation, toolpath strategies (roughing, finishing, contour), material constraints for CNC milling (wood, foam, metal),
- Laser cutting and sheet-metal fabrication: kerf compensation, nesting for material efficiency, living hinges, press-fit joinery,
- 3D printing in architecture: FDM, SLA, binder jetting, and concrete 3D printing (COBOD, ICON); layer resolution, support structures, material options,
- Digital-to-physical fabrication workflows: parametric model → fabrication file → machine → assembly
- Fabrication-driven joinery: mortise and tenon cut by CNC, snap-fit and press-fit joints, tab-and-slot connections,

Non Core

- Full-scale robotic and CNC construction: robotic bricklaying (Hadrian X), automated rebar tying, CNC-cut mass timber frames (Gramazio Kohler),

Learning Outcomes:

Core:

1. Describe the principal digital fabrication technologies - CNC milling, laser cutting, and 3D printing - [Familiarity]
2. Develop a digital fabrication workflow for an architectural element - from parametric model to toolpath generation - producing a physical prototype that meets defined dimensional [Usage]

NonCore:

3. Evaluate the feasibility of applying a digital fabrication method at building scale, assessing technical maturity, cost, speed, waste generation, [Assessment]

A.3.8 BTC/Robotic and Automated Construction

Covers the application of robotic systems to construction: on-site robots, autonomous vehicles, drones, and exoskeletons - and the implications for architectural design and detailing.

Topics:

Non Core

- Types of construction robots: bricklaying robots (SAM100), steel erection robots, concrete printing gantries, autonomous mobile platforms, and drone-based inspection
- Design for robotic construction: tolerances, repetition, and standardization required for robotic assembly
- Autonomous construction vehicles: self-driving excavators, graders, and compactors; GPS/LiDAR-guided earthworks and their impact on site planning, accuracy, and labor requirements
- Drone-based construction inspection and survey: photogrammetric as-built modeling, progress monitoring against BIM, defect detection using thermal imaging. See also: Multidisciplinary Model Coordination
- Collaborative robotics (cobots) on construction sites: human-robot task sharing, exoskeletons for load assistance, safety monitoring systems,
- Robotic construction workflows: from BIM model to robotic instructions; data exchange formats (IFC, G-code), simulation of robotic construction sequences. See also: BIM Fundamentals and Authoring

Learning Outcomes:

NonCore:

1. Identify the principal types of robotic and automated construction systems and describe their current capabilities, limitations, [Familiarity]
2. Design an architectural element or construction sequence that exploits robotic fabrication or assembly, specifying the robot type, toolpath logic, [Usage]
3. Evaluate the feasibility and cost-benefit of introducing robotic construction into a specific building project, considering site constraints, component geometry [Assessment]

A.4 Structural Systems for Architecture (STR)

Structural Systems for Architecture provides the essential knowledge of structural behavior, material properties, and load transfer mechanisms required to design safe, efficient, and expressive buildings. It spans from fundamental mechanics to advanced topics such as long-span structures, seismic design, and AI-assisted optimization. Students learn to collaborate effectively with structural engineers and to integrate structural logic as a generative driver of architectural form.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.4.1 Structural Principles and Mechanics (Pg.. 228)	1	1
⭐ A.4.2 Vertical Load Path and Foundations (Pg.. 229)	1	1
⭐ A.4.3 Residential and Vernacular Structural Systems (Pg.. 229)	1	1
⭐ A.4.4 Lateral Load-Resisting Systems (Pg.. 230)	1	1
⭐ A.4.5 Long-Span and Special Structures (Pg.. 230)	1	1
⭐ A.4.6 Structural Morphology and Form-Finding (Pg.. 231)	1	1
⭐ A.4.7 Computational Structural Analysis (Pg.. 231)	1	1
⭐ A.4.8 Foundation and Geotechnical Considerations (Pg.. 232)	1	1
⭐ A.4.9 Seismic Design for Architecture (Pg.. 232)	1	1
A.4.10 AI-Assisted Structural Optimization (Pg.. 233)	Elective	

Table A.4: List of KUs in the Structural Systems for Architecture area.

A.4.1 STR/Structural Principles and Mechanics (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the fundamental principles of structural mechanics: equilibrium, load paths, internal forces (tension, compression, shear, bending, torsion), and the behavior of structural materials under load.

Topics:

Core

- Types of loads: dead, live, snow, wind, seismic, and thermal; load combinations per ASCE 7; internal force diagrams (axial, shear, moment) in statically determinate beams

- Stress-strain relationships for common structural materials: elastic and plastic behavior, yield strength, ultimate strength, modulus of elasticity, and ductility
- Static equilibrium equations ($\sum F_x = 0$, $\sum F_y = 0$, $\sum M = 0$) and calculation of support reactions in beams, trusses, and simple frames
- Truss analysis: method of joints, method of sections, zero-force members, and truss configurations (howe, pratt, warren, vierendeel) for different span conditions
- Beam deflection: moment-area method, superposition, and the role of deflection limits (L/360, L/240) in serviceability design

Learning Outcomes:

Core:

1. Describe the primary types of structural loads and internal forces, and explain how they influence the sizing and configuration of structural elements [Familiarity]
2. Calculate support reactions, shear and moment diagrams, and deflection in simple statically determinate beams and trusses [Usage]
3. Evaluate the structural adequacy of a simple beam or truss configuration against given load and deflection criteria, proposing cross-section or material changes where needed [Assessment]

A.4.2 STR/Vertical Load Path and Foundations (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the vertical gravity load path from structural elements to the foundation: column and wall behavior, foundation systems, and structural grid coordination.

Topics:

Core

- Vertical load-bearing systems: short vs. slender columns, buckling (Euler), effective length factor; load-bearing walls (masonry, concrete, timber, steel studs)
- Foundation systems and load transfer: spread footings, continuous footings, pile caps, grade beams, and the role of connections in ensuring load path continuity
- Structural grid design: bay sizes, column spacing implications for floor framing (one-way vs. two-way slabs, beam-and-girder, flat plate, flat slab),

Learning Outcomes:

Core:

1. Identify the primary vertical load-bearing elements and foundation systems in a building, and describe how loads are transferred from the structural grid to the foundation [Familiarity]
2. Select and configure an appropriate column/wall system, foundation type, and structural grid for a medium-rise building, considering program and material availability [Usage]
3. Evaluate a building's vertical load path for continuity and foundation adequacy, identifying potential load-transfer discontinuities [Assessment]

A.4.3 STR/Residential and Vernacular Structural Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the structural systems most commonly used in single-family and low-rise residential construction, from engineered confined masonry to vernacular timber and reinforced earthen construction.

Topics:

Core

- Confined masonry (albañilería confinada): masonry walls confined by cast-in-place reinforced-concrete tie-columns and tie-beams, its seismic behavior and failure modes, and its role as Peru's dominant residential construction system under RNE Norma E.070
- Timber structural systems: heavy-timber post-and-beam framing, light wood framing (platform framing), mass timber (CLT, glulam), and the connections that distinguish each system's load path and seismic behavior
- Reinforced and improved adobe (adobe mejorado): seismic retrofitting of earthen walls with geogrid/geomesh, cane (caña), or wire mesh reinforcement to mitigate the brittle failure of plain adobe, per Peru's RNE Norma E.080

Learning Outcomes:
Core:

1. Identify confined masonry, timber, and reinforced earthen construction as structural systems, and describe their seismic behavior, failure modes, and appropriate use contexts [Familiarity]
2. Select and detail an appropriate residential structural system - confined masonry, timber framing, or reinforced adobe - for a single-family house, considering material availability, cost, and seismic performance [Usage]
3. Evaluate a single-family house's structural system for seismic adequacy and constructability, identifying code-compliance gaps under RNE Norma E.070 or E.080 as applicable [Assessment]

A.4.4 STR/Lateral Load-Resisting Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the structural systems that resist lateral (wind and seismic) loads in mid-rise buildings: moment and braced frames, shear walls, and the diaphragms that transfer lateral loads to them.
Topics:
Core

- Horizontal load-resisting systems: moment-resisting frames (rigid connections), braced frames (concentric, eccentric), shear walls (concrete, plywood, CLT),
- Floor and roof diaphragms: rigid vs. flexible diaphragm behavior, chord forces, collector elements, and load transfer from diaphragms to vertical lateral-resisting elements

Learning Outcomes:
Core:

1. Identify the primary lateral load-resisting systems - moment frames, braced frames, shear walls - and describe the role of floor and roof diaphragms in transferring lateral loads to them [Familiarity]
2. Select and configure an appropriate lateral load-resisting system - moment frame, braced frame, or shear wall - for a mid-rise collective-housing building, coordinating it with the floor diaphragm [Usage]
3. Evaluate a mid-rise building's lateral system for configuration irregularities (soft stories, torsional irregularities) and diaphragm continuity [Assessment]

A.4.5 STR/Long-Span and Special Structures (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers structural systems for large clear spans: arches, vaults, domes, space frames, trusses, cable nets, tensile membranes, and folded plates.
Topics:
Core

- Arches and vaults: funicular compression geometry, buttressing requirements, ribbed vs. continuous vaults, and historic and contemporary applications (Guastavino, Candela)
- Domes and shells: membrane theory, edge ring forces, buckling in thin shells, geodesic domes (Fuller), and reinforced concrete shells (Nervi, Isler)
- Space frames and long-span trusses: three-dimensional truss action, node design, modular systems (Mero, Unistrut), and application in arenas, airports, and exhibition halls
- Tensile and cable structures: cable nets (Frei Otto), fabric membranes (PTFE-coated fiberglass, ETFE), masts and anchorage design, and form-finding via physical
- Folded plate structures: corrugated geometry for stiffness, folded plate concrete roofs, and timber folded plate systems (CLT folded plates)

Non Core

- Deployable and transformable structures: scissor linkages, pantographic systems, and their application in retractable roofs, emergency shelters, and kinetic architecture

Learning Outcomes:
Core:

1. Describe the principal long-span structural systems - arches, domes, space frames, tensile membranes - and identify the appropriate span range [Familiarity]
2. Select and conceptualize a long-span structural system for a given program (e.g., stadium, airport terminal, convention center), justifying the choice by span, load, [Usage]

3. Evaluate the structural efficiency and architectural expression of a built long-span structure, analyzing its load path, stability, and integration of form with structural logic [Assessment]

A.4.6 STR/Structural Morphology and Form-Finding (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the relationship between structural form and internal force flow: funicular geometry, graphic statics, physical form-finding, and computational optimization for material efficiency.

Topics:

Core

- Funicular forms: compression-only (arches, vaults) and tension-only (cables) geometries; the relationship between shape and internal forces; thrust line analysis for arches
- Graphic statics: form diagram, force diagram, and their reciprocal relationship for funicular design; application to trusses and masonry vault analysis
- Physical form-finding: hanging-chain models (Gaudi), soap-film analogues, and fabric formwork; scaling laws and materiality in physical models for compression
- Computational form-finding: dynamic relaxation, particle-spring systems, and finite element-based shape optimization for minimal surface and funicular geometries

Non Core

- Topology optimization for structural layout: SIMP method, solid-void distribution, and generation of bone-like material-efficient structural morphologies for additive manufacturing

Learning Outcomes:

Core:

1. Describe the concept of funicular form and explain how the shape of a structure can be derived from its internal force flow using graphic statics or physical form-finding [Familiarity]
2. Apply graphic statics or computational form-finding to design a compression-only or tension-only structure that is in pure axial equilibrium for a given load [Usage]
3. Evaluate a form-found structure for material efficiency and structural integrity, comparing its performance to a conventionally designed counterpart [Assessment]

A.4.7 STR/Computational Structural Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of computational tools for structural analysis: finite element methods, BIM-integrated analysis workflows, and parametric structural modeling for iterative design exploration.

Topics:

Core

- Finite element method basics: discretization, element types (beam, shell, solid), boundary conditions, load application, and interpretation of stress, displacement,
- Parametric structural modeling: linking geometric parameters (span, spacing, depth) to analysis results via Grasshopper-Karamba or Dynamo- Robot
- BIM-based structural workflows: structural analysis model from architectural BIM (Revit, Tekla), data exchange via IFC or CIS/2, from the structural-analysis side. See also: BIM for Structural and MEP Coordination
- Stability analysis: eigenvalue buckling analysis for slender structures, geometrically nonlinear analysis for cable nets and membranes, and second-order effects (P-Δ)

Non Core

- Nonlinear material analysis: plasticity, cracking in concrete, post-yield behavior of steel, and performance-based design using pushover analysis (nonlinear static)

Learning Outcomes:

Core:

1. Describe the steps of a finite element structural analysis workflow and the role of mesh refinement, boundary conditions, and material properties in result accuracy [Familiarity]
2. Set up a parametric structural model to analyze the stress and deflection of a beam or frame under varying geometric parameters [Usage]

3. Evaluate the results of a computational structural analysis for plausibility and convergence, identifying modeling errors or unrealistic assumptions in loads or supports [Assessment]

A.4.8 STR/Foundation and Geotechnical Considerations (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the interaction between buildings and the ground: soil properties, bearing capacity, settlement, foundation types, and retaining structures.

Topics:

Core

- Soil properties and site investigation: grain size distribution, Atterberg limits, shear strength (cohesion, friction angle), compressibility,
- Bearing capacity and settlement: Terzaghi's bearing capacity equation, allowable bearing pressure, immediate and consolidation settlement,
- Shallow foundations: spread footings, continuous footings, mat (raft) foundations; sizing for column loads and uplift, reinforcement detailing, and frost protection
- Deep foundations: driven piles (steel, concrete, timber), drilled shafts (caissons), pile capacity (end-bearing + skin friction), pile groups, and negative skin friction
- Retaining walls: gravity, cantilever, sheet pile, and anchored walls; active and passive earth pressure (Rankine, Coulomb); drainage and stability against sliding and overturning

Learning Outcomes:

Core:

1. Identify the key soil properties that influence foundation design and describe the difference between shallow and deep foundation systems and their appropriate applications [Familiarity]
2. Size a shallow foundation (spread footing) for given column loads and soil bearing capacity, verifying settlement and reinforcing requirements against code limits [Usage]
3. Evaluate a foundation design proposal for stability, settlement, and constructability, recommending changes where geotechnical risks are inadequately addressed [Assessment]

A.4.9 STR/Seismic Design for Architecture (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers seismic design principles for buildings: seismic hazards, response spectra, lateral force-resisting systems, ductility, and the architectural detailing required for earthquake resilience.

Topics:

Core

- Seismic hazards and site effects: fault rupture, ground shaking, liquefaction, landslide; site class effects on ground motion amplification
- Lateral force-resisting systems for seismic resistance: moment frames, braced frames (concentric, eccentric), shear walls (reinforced concrete, wood), and dual systems
- Ductility and capacity design: strong-column weak-beam, plastic hinge formation, confinement reinforcement in concrete columns,
- Architectural integration of seismic systems: drift limits for cladding and partitions, seismic joints, diaphragm continuity,
- Base isolation and energy dissipation: elastomeric and sliding bearings, tuned mass dampers, viscous dampers, and their impact on architectural detailing

Non Core

- Performance-based seismic design (PBSD): performance objectives (immediate occupancy, life safety, collapse prevention), nonlinear static pushover analysis,

Learning Outcomes:

Core:

1. Describe the primary seismic force-resisting systems and explain how building codes classify seismic risk and prescribe detailing for ductile behavior [Familiarity]
2. Apply seismic design principles to the early-stage design of a building, selecting an appropriate lateral system and configuring plan [Usage]
3. Evaluate an architectural design for seismic vulnerability, identifying plan irregularities (re-entrant corners, diaphragm discontinuities) [Assessment]

A.4.10 STR/AI-Assisted Structural Optimization

Covers the application of machine learning and artificial intelligence to structural design: surrogate modeling, generative design, reinforcement learning for layout, and AI-assisted code compliance checking.

Topics:

Non Core

- Surrogate modeling for structural analysis: training neural networks to predict stress, deflection, or buckling load as fast approximations of finite element simulations for use
- Generative design for structural layout: using evolutionary algorithms and GANs to produce diverse structural configurations (column grids
- Reinforcement learning for structural topology: training RL agents to add or remove material in a design domain to achieve minimum compliance or weight, producing efficient
- AI-assisted code compliance checking for structures: NLP for parsing seismic and wind provisions, automated rule checking of structural BIM models against IBC. See also: AI-Assisted BIM Automation
- Machine learning for failure mode prediction: training classifiers to identify potential failure modes (buckling, yielding

Learning Outcomes:

NonCore:

1. Identify the main applications of AI and machine learning in structural engineering and architecture - surrogate modeling, generative design, and code checking - [Familiarity]
2. Apply a surrogate machine learning model to accelerate the evaluation of structural performance within a parametric design workflow [Usage]
3. Evaluate the validity and reliability of an AI-assisted structural optimization result, identifying potential overfitting, lack of physical consistency [Assessment]

A.5 Environmental Systems and Sustainability (ENV)

Environmental Systems and Sustainability provides the knowledge and tools to design buildings that are thermally comfortable, visually healthy, acoustically sound, and resource-efficient. It covers passive and active environmental control strategies, energy and water systems, and regenerative design frameworks that go beyond net-zero to net-positive and circular models. Students learn to simulate and optimize building performance from early design stages.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.5.1 Daylighting and Visual Comfort (Pg.. 233)	1	1
⭐ A.5.2 Thermal Comfort and Passive Systems (Pg.. 234)	1	1
⭐ A.5.3 Natural Ventilation and Indoor Air Quality (Pg.. 234)	1	1
⭐ A.5.4 Mechanical Systems (HVAC) (Pg.. 235)	1	1
⭐ A.5.5 Building Automation and Smart Systems (Pg.. 235)	1	1
⭐ A.5.6 Acoustics and Noise Control (Pg.. 236)	1	1
⭐ A.5.7 Energy Efficiency and Net-Zero Design (Pg.. 236)	1	1
⭐ A.5.8 Water, Sanitation, and Waste Systems (Pg.. 237)	1	1
⭐ A.5.9 Regenerative and Circular Design (Pg.. 237)	1	1
A.5.10 Climate Resilience and Adaptation (Pg.. 238)	Elective	

Table A.5: List of KUs in the Environmental Systems and Sustainability area.

A.5.1 ENV/Daylighting and Visual Comfort (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design of building apertures and shading to provide adequate illuminance while controlling glare and solar heat gain: daylight metrics, simulation tools, and integration with electric lighting.

Topics:

Core

- Daylight performance metrics: daylight factor (DF), spatial daylight autonomy (sDA), annual sunlight exposure (ASE), useful daylight illuminance (UDI), and glare indices (DGP, DGI)
- Aperture design for daylight: window-to-wall ratio (WWR), head height, sill height, clerestories, sawtooth roofs, light shelves,
- Shading integration for glare and cooling: fixed (overhangs, fins, louvers), operable (roller shades, venetian blinds, screens),
- Daylight simulation tools: climate-based modeling (Radiance, DIVA, ClimateStudio, Ladybug Tools); annual simulation for LEED and other certification credits
- Electric lighting integration: daylight harvesting controls (dimming, stepped switching), task-ambient lighting strategies,

Learning Outcomes:
Core:

1. Describe the principal daylight performance metrics (sDA, ASE, UDI) and explain how they inform aperture and shading design decisions [Familiarity]
2. Design and simulate a daylighting strategy for a building facade or roof aperture, iterating on WWR, orientation, and shading to meet defined sDA and ASE targets [Usage]
3. Evaluate a building's daylighting design from simulation outputs, identifying areas of glare or insufficient illuminance [Assessment]

A.5.2 ENV/Thermal Comfort and Passive Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the physics of heat transfer in buildings, thermal comfort indices, and passive heating and cooling strategies that reduce or eliminate mechanical system loads.
Topics:
Core

- Heat transfer mechanisms in buildings: conduction through assemblies (U-value), convection at surfaces and within cavities, and long-wave
- Thermal comfort indices: PMV (predicted mean vote), PPD (predicted percentage dissatisfied), operative temperature,
- Passive solar heating: direct gain (south-facing glazing + thermal mass), indirect gain (Trombe wall, water wall), isolated gain (sunspace)
- Passive cooling strategies: night-flush ventilation, radiative cooling to the night sky, earth coupling (earth tubes, berming), evaporative cooling (roof ponds, fountains),
- Thermal mass strategies: phase change materials (PCMs), exposed concrete or masonry for diurnal heat storage, and the placement of mass relative to insulation and solar gains

Learning Outcomes:
Core:

1. Describe the heat transfer mechanisms that affect building thermal performance and explain the difference between predicted mean vote (PMV) and adaptive thermal comfort models [Familiarity]
2. Select and apply appropriate passive heating and cooling strategies for a building in a given climate, sizing apertures and mass to reduce predicted heating and cooling loads [Usage]
3. Evaluate a building's thermal design using simulation or hand calculation, identifying strategies that are underperforming [Assessment]

A.5.3 ENV/Natural Ventilation and Indoor Air Quality (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design of naturally ventilated buildings: stack effect, cross-ventilation, wind-driven flow, air quality standards, and hybrid (mixed-mode) ventilation strategies.
Topics:
Core

- Drivers for natural ventilation: wind pressure coefficients (C_p), stack effect (buoyancy), and combined wind and stack; ventilation rate calculation using the orifice equation

- Cross-ventilation and stack ventilation design: opening placement (inlet vs. outlet heights), room depth limits for effective cross-flow (2-2.5× floor-to-ceiling height)
- Indoor air quality standards and contaminants: ASHRAE 62.1 ventilation rate procedure, indoor pollutant sources (VOCs, CO_2, particulates),
- Mixed-mode (hybrid) ventilation: sequencing strategies (changeover, zoned, concurrent), control logic for switching between natural and mechanical modes,
- Airflow simulation for natural ventilation: computational fluid dynamics (CFD) for detailed analysis, zonal models for early design, and wind tunnel testing for complex geometries

Learning Outcomes:
Core:

1. Describe the physical drivers of natural ventilation - wind and stack effect - and explain how opening size, placement, and building depth influence airflow rates [Familiarity]
2. Design a natural ventilation strategy for a building in a moderate climate, specifying opening sizes, heights, [Usage]
3. Evaluate a naturally ventilated building design using airflow simulation or simplified calculations, identifying zones with insufficient ventilation [Assessment]

A.5.4 ENV/Mechanical Systems (HVAC) (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the principles of heating, ventilation, and air conditioning (HVAC) systems: system types, component selection, distribution methods, and integration with architectural design.
Topics:
Core

- HVAC system classification: all-air (VAV, CAV, dual-duct), all-water (fan-coil, radiant), air-water (induction), and decentralized (heat pumps, PTAC, split systems)
- Thermal zoning and load calculation: zone definition by orientation, occupancy, and use; heating and cooling load components (sensible, latent); peak load vs. part-load performance
- Distribution system integration: ceiling plenum depth for ducts, raised floors for underfloor air distribution (UFAD), vertical riser coordination,
- Dedicated outdoor air systems (DOAS) and energy recovery: enthalpy wheels, run-around loops, and heat pipes
- High-efficiency HVAC technologies: variable refrigerant flow (VRF), chilled beams (active and passive), displacement ventilation, radiant heating and cooling slabs,

Learning Outcomes:
Core:

1. Identify the principal HVAC system types and describe the architectural implications of each in terms of floor-to-floor height, ceiling plenum, mechanical room space, [Familiarity]
2. Select an appropriate HVAC system type for a building program and climate zone, integrating thermal zoning and distribution layout into the architectural floor plan and section [Usage]
3. Evaluate the HVAC system layout of a building for efficiency, constructability, and architectural integration [Assessment]

A.5.5 ENV/Building Automation and Smart Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the control-layer technologies that automate and integrate a building's mechanical, electrical, and security systems: sensors and actuators, communication protocols, centralized building management, and residential smart-home applications.
Topics:
Core

- Building automation fundamentals: sensors (occupancy, temperature, light, CO2) and actuators, open-loop vs. closed-loop control, and centralized building management systems (BMS/BAS) vs. distributed and edge control architectures
- Building and home automation protocols: wired standards (KNX, BACnet, Modbus) and wireless standards (Zigbee, Z-Wave, Matter/Thread, Wi-Fi); interoperability and vendor lock-in considerations

- Integrated systems control: unifying HVAC, lighting, shading, security and access control, and irrigation under a single automation layer; scenes, scheduling, and occupancy-based automation

- Energy monitoring and demand response: submetering, real-time energy dashboards, and automated load shedding and peak-demand management through building automation

Non Core

- Residential smart-home applications: voice assistants, smart appliances and locks, and automation for accessibility and aging-in-place

Learning Outcomes:

Core:

1. Identify the core components of a building automation system - sensors, actuators, controllers, and communication protocols - and describe how they integrate HVAC, lighting, and security systems [Familiarity]
2. Specify a building automation strategy for a design project, selecting appropriate sensors, control protocols, and integrated systems for the building's program and scale [Usage]
3. Evaluate a building automation proposal for interoperability, energy-saving potential, and appropriateness to the building's program and occupant needs [Assessment]

A.5.6 ENV/Acoustics and Noise Control (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the physics of sound in buildings: sound transmission, absorption, reverberation, noise control, and the design of spaces with specific acoustic performance criteria (theaters, classrooms, open offices).

Topics:

Core

- Sound measurement metrics: sound pressure level (SPL, dB), A-weighting (dBA), reverberation time (RT_{60}), sound transmission class (STC), impact insulation class (IIC),
- Absorption and diffusion: porous absorbers (fiberglass, foam), resonant absorbers (perforated panels, membrane), and diffusers (quadratic residue, binary amplitude)
- Sound isolation and flanking paths: mass-law, double-wall and decoupled assemblies, sealed penetrations, gasketed doors, floating floors,
- Room acoustic design: calculating RT_{60} from volume and absorption, early decay time (EDT), clarity (C50, C80), and speech intelligibility (STI) for auditoria, classrooms,
- Noise control from external sources: site planning for noise barriers, facade STC selection based on exterior noise levels (road, rail, air),

Learning Outcomes:

Core:

1. Describe the key acoustic metrics (STC, IIC, RT60, NC) and explain how each influences the design of building assemblies and room finishes [Familiarity]
2. Design a wall and floor-ceiling assembly to meet a specified STC and IIC rating, detailing flanking path controls and penetrations to achieve target isolation [Usage]
3. Evaluate a room's acoustic design by calculating its reverberation time and comparing it to recommended values for its intended use (lecture, music, conferencing) [Assessment]

A.5.7 ENV/Energy Efficiency and Net-Zero Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers strategies for reducing building energy demand to near zero and meeting residual loads with on-site renewable energy: energy modeling, efficiency measures, and renewable system integration.

Topics:

Core

- Building energy modeling (BEM): physics-based simulation (EnergyPlus, eQUEST, IES VE), input parameters (envelope, lighting, HVAC, schedules, plug loads),
- Efficiency-first approach: envelope optimization (high R-value, low air leakage), high-performance glazing, efficient lighting (LED with controls),
- On-site renewable energy: photovoltaic (PV) array sizing (roof, facade, parking canopy), inverter selection, and estimating annual production (PVWatts, SAM)

- Zero energy certification frameworks: NZEB (zero net energy building) definitions by DOE, Living Building Challenge Energy Petal, and Passive House Plus
- Deep energy retrofit for existing buildings: envelope upgrades (window replacement, exterior insulation), HVAC replacement with heat pumps, and lighting retrofit

Learning Outcomes:
Core:

1. Describe the components of a net-zero energy building design - load reduction, efficiency, and on-site renewables - [Familiarity]
2. Perform a preliminary energy balance for a building design, calculating estimated EUI from a simple model and sizing a PV array to offset annual energy consumption [Usage]
3. Evaluate a proposed net-zero building design by reviewing its energy model inputs and assumptions, identifying unrealistic plug load estimates or insufficient PV area, [Assessment]

A.5.8 ENV/Water, Sanitation, and Waste Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers water supply, sanitation, and waste systems in buildings: potable and non-potable water, rainwater harvesting, greywater reuse, blackwater treatment, and solid waste management.
Topics:
Core

- Building water supply: pressure and flow requirements, sizing of supply pipes, hot water circulation systems, water heating technologies (tankless, heat pump, solar thermal),
- Sanitary drainage and venting: DWV system design (drain, waste, vent), trap seal protection, slope requirements, and grease interceptors for commercial kitchens
- Rainwater harvesting: catchment area (roof), gutter and downspout sizing, first-flush diversion, storage tank sizing based on demand and rainfall, filtration,
- Greywater and blackwater treatment: greywater sources (lavatories, laundry) and reuse for subsurface irrigation
- Solid waste management in buildings: waste sorting (recycling, compost, landfill), chute systems, compactors, and space allocation for waste storage

Learning Outcomes:
Core:

1. Describe the components of building water supply and drainage systems and explain the difference between potable, non-potable, greywater, [Familiarity]
2. Design a rainwater harvesting system for a building, sizing the storage tank based on roof area, local rainfall data, and non-potable demand (toilet flushing, irrigation) [Usage]
3. Evaluate the water efficiency strategy of a building project using LEED v4.1 water efficiency credits, identifying opportunities for water savings via fixture selection, reuse [Assessment]

A.5.9 ENV/Regenerative and Circular Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers regenerative design frameworks that go beyond sustainability to net-positive environmental impact: circular material flows, biogenic carbon, ecosystem services, and social-ecological resilience.
Topics:
Core

- Regenerative design principles: building as a living system, net-positive energy (beyond zero), net-positive water,
- Circular construction at building scale: design for adaptability (loose-fit, long-life), design for disassembly (reversible connections, material separation),
- Biogenic carbon in construction: timber, bamboo, hemp, straw, and mycelium as carbon-storing materials; lifecycle assessment including biogenic sequestration
- Living Building Challenge (LBC) framework: seven petals (place, water, energy, health/happiness, materials, equity, beauty)
- Biodiversity net gain: green roofs, living walls, pollinator corridors, bird-safe glazing, and native planting to exceed pre-development ecological value

Learning Outcomes:
Core:

1. Describe the principles of regenerative and circular design - net-positive performance, design for disassembly, biogenic carbon, and ecosystem enhancement - [Familiarity]
2. Design a building element or assembly for disassembly using reversible connections and material separation, documenting the end-of-life material recovery strategy [Usage]
3. Evaluate a building design against Living Building Challenge imperatives, identifying gaps in energy, water, or material performance [Assessment]

A.5.10 ENV/Climate Resilience and Adaptation

Covers the design of buildings and settlements that are resilient to climate-induced hazards: flooding, extreme heat, wildfire, sea level rise, and windstorms.
Topics:
Non Core

- Flood resilience strategies: elevated buildings (crawl space, piles, stilts), dry floodproofing (watertight enclosures), wet floodproofing (flood vents),
- Design for extreme heat: cool roofs (high solar reflectance), cool pavements, shading of outdoor spaces (trees, canopies), nighttime natural ventilation,
- Wildfire resilience in the wildland-urban interface (WUI): ignition-resistant construction (Class A roofing, metal screens for vents), defensible space zones
- Windstorm and hurricane resilience: impact-resistant glazing, shutter systems, roof-to-wall connections (hurricane ties),
- Passive survivability during extended power outages: thermal autonomy (superinsulation, high thermal mass, earth sheltering), passive ventilation, and access to potable water

Learning Outcomes:
NonCore:

1. Identify the primary climate hazards affecting a given geographic region and describe the building-scale design strategies that enhance resilience to each hazard [Familiarity]
2. Design a building envelope and site layout for flood or wildfire resilience, specifying elevation strategies, ignition-resistant detailing [Usage]
3. Evaluate a building design for climate resilience using a hazard-specific checklist (flood, heat, wildfire, wind), recommending modifications to improve passive survivability [Assessment]

A.6 Urban Design and Planning (UDP)

Urban Design and Planning addresses the organization of the built environment at scales from block to region. It covers urban morphology, planning theories, housing, informal settlements, data-driven urban analytics, digital twins, landscape and open space design, and social equity in urban development. Students learn to analyze and design urban environments that are functional, resilient, equitable, and beautiful.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.6.1 Urban Form and Morphology (Pg.. 239)	1	1
⭐ A.6.2 Historical Urban Planning Theories (Pg.. 239)	1	1
⭐ A.6.3 Contemporary Planning Methods and Theory (Pg.. 239)	1	1
⭐ A.6.4 Urban Design at Multiple Scales (Pg.. 240)	1	1
⭐ A.6.5 Housing and Residential Environments (Pg.. 240)	1	1
⭐ A.6.6 Informal Settlements and Incremental Urbanization (Pg.. 241)	1	1
⭐ A.6.7 Urban Data Science and GeoAI (Pg.. 241)	1	1
A.6.8 Smart Cities and Urban Digital Twins (Pg.. 242)	Elective	
⭐ A.6.9 Landscape and Open Space Design (Pg.. 242)	1	1
⭐ A.6.10 Social Equity and Inclusive Urbanism (Pg.. 243)	1	1

Table A.6: List of KUs in the Urban Design and Planning area.

A.6.1 UDP/Urban Form and Morphology (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the study of urban form: streets, blocks, plots, buildings, and open spaces as morphological units, and the analytical methods used to describe and classify urban tissues.

Topics:

Core

- Kevin Lynch's city image elements: paths, edges, districts, nodes, and landmarks; their role in legibility and wayfinding; application to urban design analysis and intervention
- Street, block, and plot systems: typologies (grid, radial, organic, cul-de-sac), block dimensions and permeability, plot subdivision,
- Urban building typologies: single-family detached, row house (townhouse), courtyard building, slab, point tower, and linear block
- Morphological analysis methods: Conzenian (burgage cycle, fringe belts), space syntax (integration, connectivity, choice), and figure-ground diagrams for reading urban form
- Urban fabric layers: plot subdivision history, street network evolution, land use succession, and the persistence of plot boundaries over centuries as a design constraint

Learning Outcomes:

Core:

1. Identify the key morphological elements of a city - streets, blocks, plots, buildings - and describe the relationships among them that define urban character [Familiarity]
2. Apply morphological analysis tools (figure-ground, space syntax) to an urban sector, identifying its legibility, connectivity, and typological diversity [Usage]
3. Evaluate the morphological coherence and permeability of a proposed urban design, comparing block sizes, street connectivity, [Assessment]

A.6.2 UDP/Historical Urban Planning Theories (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the historical development of urban planning theories from early-20th-century utopian visions through the critique of post-war master planning: the Garden City, the Radiant City, Broadacre City, and the Team 10 and Jane Jacobs response.

Topics:

Core

- Classic urban theories: Howard's Garden City, Le Corbusier's Radiant City (Towers in the Park), Wright's Broadacre City, and their influence on 20th-century planning and zoning
- Post-WWII planning: the rise of the master plan, Team 10 critique of CIAM, Jane Jacobs' advocacy for mixed-use and short blocks,

Learning Outcomes:

Core:

1. Describe the key historical urban planning theories and their influence on 20th-century city form, and explain the shift from master planning to strategic [Familiarity]

A.6.3 UDP/Contemporary Planning Methods and Theory (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the planning methods used to implement urban visions (zoning, master vs. strategic planning, public participation), smart growth and new urbanism principles, contemporary urban theory, and the integration of civil engineering technical constraints into planning frameworks.

Topics:

Core

- Planning methods: zoning (Euclidean, form-based, performance-based), master planning vs. strategic planning, public participation (charrettes, community workshops
- Smart growth and new urbanism: principles (transit-oriented development, walkability, mixed-income housing, urban growth boundaries), Andrés Duany's transect,
- Contemporary urban theory: Lefebvre's production of space, Harvey's right to the city, Sennett's open city, and the role of informality, participation,

Non Core

- Integration of civil engineering technical constraints (structural, geotechnical, utility infrastructure, and transportation) into urban planning and architectural design frameworks; the collaborative role of civil engineers in multidisciplinary building and urban project teams

Learning Outcomes:

Core:

1. Apply a planning method - such as form-based coding or scenario planning - to a specific urban site, producing land use or built form regulations that align with stated policy [Usage]
2. Evaluate a current urban plan or zoning code against contemporary planning principles (walkability, mixed-use, transit orientation, social equity), identifying strengths [Assessment]

A.6.4 UDP/Urban Design at Multiple Scales (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the practice of urban design across scales: regional structure, citywide network, neighborhood, block, street, and public space - and the design guidelines appropriate to each.

Topics:

Core

- Regional and city scale: transit corridors, green belts, growth boundaries, satellite towns, and the relationship between density
- Neighborhood scale: walkability (5-10 minute walking radius), mixed-use zoning, social infrastructure (schools, clinics, community centers), and the 20-minute neighborhood concept
- Block and street scale: block length for pedestrian permeability (80-120 m max), street section design (lane widths, sidewalks, bike lanes, street trees, furniture zone),
- Public space design: squares, plazas, parks, pocket parks, and streets as public space; William Whyte's elements of successful public space (sittable space, sun, food
- Urban design guidelines: building setbacks, height limits, architectural character, facade articulation, signage, lighting,

Learning Outcomes:

Core:

1. Describe the key design considerations at each urban scale - regional, neighborhood, block, street, and public space - [Familiarity]
2. Develop a set of urban design guidelines for a specific neighborhood or street typology, integrating density, building height, block length, street section, [Usage]
3. Evaluate an urban design project for its multi-scale coherence, assessing how well it integrates regional transit, neighborhood walkability, block permeability, street safety, [Assessment]

A.6.5 UDP/Housing and Residential Environments (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design and planning of housing at multiple scales: unit, building, block, and neighborhood; housing types, affordability, social mix, and the relationship between housing and urban form.

Topics:

Core

- Housing typologies: single-family detached, row house, courtyard building, walk-up apartment, point tower, slab block, double-loaded corridor,
- Affordable housing strategies: inclusionary zoning, density bonuses, cross-subsidization, public-private partnerships, community land trusts (CLTs), and the financial
- Housing quality and dweller control: orientation for sunlight and ventilation, unit deepth to window ratio, privacy thresholds (distance to opposite windows), acoustic separation
- Mixed-income and social mix housing: fostering social interaction, avoiding stigma of large public housing projects (Pruitt-Igoe lessons),
- Housing policy frameworks: Vienna's social housing model, Singapore's public housing, Chilean housing subsidies,

Learning Outcomes:

Core:

1. Identify the principal housing typologies and their urban density contributions, and describe the design qualities that distinguish high-quality residential environments from poorly designed ones [Familiarity]
2. Design a housing block at the neighborhood scale, specifying building typology mix, dwelling unit orientation and ventilation strategy, [Usage]
3. Evaluate a housing project for quality of life, affordability, and urban integration, using indicators such as floor-to-ceiling height, access to light [Assessment]

A.6.6 UDP/Informal Settlements and Incremental Urbanization (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the study of informal settlements (slums, favelas, kampongs) and incremental housing processes as legitimate forms of urban development, and the design and policy approaches for upgrading and regularization.

Topics:

Core

- The morphology of informal settlements: organic street networks, plot subdivision (loteo) patterns, self-built housing, multi-functionality of rooms,
- Slum upgrading strategies: in-situ upgrading (regularization of tenure, infrastructure provision, community facilities), relocation vs.
- Incremental housing: progressive development models (core housing with expandable shell, sites-and-services), self-construction support (technical assistance, microcredit
- Land tenure and regularization: squatter rights, adverse possession, collective title, and the impact of secure tenure on home improvement and investment
- The informal economy and urban space: street vending, home-based enterprises, market stalls, and the design of public space that accommodates informal economic activities without

Learning Outcomes:

Core:

1. Describe the morphological and social characteristics of informal settlements and explain the differences between in-situ upgrading, relocation, and sites-and-services approaches [Familiarity]
2. Design an incremental housing unit and expansion strategy for a low-income family, specifying the starter core, expandable structure, and the phasing of utilities and finishing [Usage]
3. Evaluate an informal settlement upgrading proposal for its impact on land tenure security, infrastructure access, displacement risk, and community participation [Assessment]

A.6.7 UDP/Urban Data Science and GeoAI (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of geospatial data, machine learning, and urban analytics to analyze and inform urban design and planning decisions: mobility patterns, land use classification, accessibility analysis, and predictive modeling.

Topics:

Core

- Urban data sources: census data, points of interest (POI), mobile phone location data, GPS traces, transit smart card data, social media check-ins, satellite imagery (Sentinel
- Spatial analysis methods: network analysis (shortest path, service area, connectivity), isochrones, density analysis (kernel density), spatial autocorrelation (Moran's I),
- Accessibility metrics: job accessibility by transit, walkability indices (WalkScore), bikeability, food deserts,
- Machine learning for urban analysis: land use classification from satellite imagery (CNN), clustering of urban morphologies, prediction of travel demand,
- Urban dashboards and decision support: City dashboards (NYC, London, Singapore), real-time mobility monitoring, scenario comparison,

Learning Outcomes:

Core:

1. Describe the main sources of urban data and the spatial analysis methods used to derive insights about mobility, accessibility, land use, and urban form [Familiarity]

2. Apply a spatial analysis workflow to assess pedestrian accessibility to public transit, generating isochrones and calculating population coverage [Usage]
3. Evaluate the quality and limitations of an urban data set for a specific planning question (e.g., equitable access to parks), identifying biases (sampling, demographic gaps) [Assessment]

A.6.8 UDP/Smart Cities and Urban Digital Twins

Covers the emerging field of urban digital twins: real-time city models, IoT data integration, simulation of urban scenarios, and the use of digital twins for planning, operations, and citizen engagement.
Topics:
Non Core

- Definition of urban digital twin: a virtual replica of the city that updates in near real-time via IoT sensors, integrates multiple domain models (transport, energy, water
- Data standards for urban digital twins: CityGML (LOD0-LOD4), 3D Tiles, IFC for buildings, and the integration of BIM into city-scale models; semantic enrichment for urban analytics. See also: BIM for Infrastructure and Urban Modeling
- IoT sensor networks for cities: air quality sensors, traffic counters, parking occupancy, waste bin levels, noise monitors, and citizen-reported data via mobile apps
- Urban simulation use cases: scenario planning (zoning changes, pedestrianization, transit expansion), what-if analysis of climate adaptation strategies,
- Privacy and ethical challenges in urban digital twins: data ownership, consent for passive data collection (mobile phone location, cameras), algorithmic bias in urban models,

Learning Outcomes:
NonCore:

1. Describe the components of an urban digital twin - real-time data, 3D city model, simulation engine - and explain how they differ from a conventional 3D city GIS model [Familiarity]
2. Use a digital twin or urban simulation platform to test the impact of a proposed zoning change or infrastructure investment on traffic congestion, air quality [Usage]
3. Evaluate the maturity and fitness-for-purpose of an urban digital twin application, assessing data resolution, update frequency, model validation, and the handling of uncertainty [Assessment]

A.6.9 UDP/Landscape and Open Space Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design of public open space: parks, plazas, greenways, waterfronts, and streets as landscape; the integration of ecological, social, and cultural functions in urban open space systems.
Topics:
Core

- Park types and their urban roles: pocket parks, neighborhood parks, district parks, regional parks, linear parks (greenways), waterfront parks, and national urban parks
- Green infrastructure in urban design: bioswales, rain gardens, permeable pavements, urban forests, and green roofs
- Placemaking for public space: Project for Public Spaces criteria (sociability, uses/activities, access, comfort/image)
- Integration of landscape and urban form: view corridors, public space networks, park-to-park connections, and the role of open space in structuring urban density and walkability
- Equity in open space access: distributional equity (distance, size per capita), quality equity (facilities, safety, maintenance),

Learning Outcomes:
Core:

1. Describe the typologies of urban open space and their appropriate spatial distribution, programming, and ecological functions [Familiarity]
2. Design a public open space (plaza, park, or greenway) that integrates stormwater management, seating, shade, and circulation into a coherent spatial composition [Usage]
3. Evaluate a public space design using placemaking criteria (access, comfort, activities, sociability) and identify modifications to improve its use frequency and user diversity [Assessment]

A.6.10 UDP/Social Equity and Inclusive Urbanism (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the social dimensions of urban design and planning: spatial justice, segregation, displacement, participatory processes, and the design of cities that serve all residents equitably.

Topics:

Core

- Spatial justice frameworks: Fainstein's just city (democracy, equity, diversity), Soja's seeking spatial justice,
- Gentrification and displacement: stages of gentrification, direct and indirect displacement (exclusionary displacement), anti-displacement strategies (rent control
- Participatory planning and community engagement: Arnstein's ladder of participation (manipulation to citizen control), deliberative methods (planning cell, consensus conference
- Equitable transportation: transit deserts, fare equity, accessibility for persons with disabilities, safe routes for walking and cycling,
- Gender-inclusive urbanism: safety audits, lighting and sightlines for perceived safety, access to childcare facilities,

Learning Outcomes:

Core:

1. Identify the main dimensions of spatial justice - distribution, procedure, recognition - and describe how urban planning decisions can produce or mitigate inequitable outcomes [Familiarity]
2. Apply an equity assessment tool (e.g., equity scorecard, health impact assessment) to an urban development proposal, identifying which populations benefit [Usage]
3. Evaluate a participatory planning process for authenticity, power-sharing, and representation, recommending changes to increase meaningful participation of marginalized [Assessment]

A.7 Professional Practice and Ethics (PRO)

Professional Practice and Ethics covers the legal, economic, regulatory, ethical, and managerial frameworks within which architectural services are delivered. It addresses the architect's roles as designer, contract administrator, businessperson, and advocate for social and environmental responsibility. Students develop the competence to manage projects, navigate regulations, collaborate across disciplines, and practice with integrity.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.7.1 Architecture as a Profession (Pg.. 243)	1	1
⭐ A.7.2 Project Delivery Methods and Contracts (Pg.. 244)	1	1
⭐ A.7.3 Project Management and Construction Economics (Pg.. 244)	1	1
⭐ A.7.4 Collaborative and Interdisciplinary Practice (Pg.. 245)	1	1
⭐ A.7.5 Ethics, Decolonial Practice, and Social Responsibility (Pg.. 245)	1	1
A.7.6 Business of Architecture and Entrepreneurship (Pg.. 246)	Elective	
A.7.7 Future of the Profession: AI and New Roles (Pg.. 246)	Elective	

Table A.7: List of KUs in the Professional Practice and Ethics area.

A.7.1 PRO/Architecture as a Profession (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the structure of the architectural profession: registration and licensing, professional organizations, continuing education, and the evolving scope of architectural practice.

Topics:

Core

- Architectural licensing and registration: education, experience, and examination (ARE) requirements; reciprocity
- Professional organizations: AIA (American Institute of Architects), RIBA (Royal Institute of British Architects), CAF (Colegio de Arquitectos de Chile, etc.),

- Practice models: traditional sole proprietorship, partnerships, corporations, PLLCs; multi-disciplinary firms (architecture-engineering); virtual and distributed practice
- The architect's expanded role: prime consultant, contract administrator, sustainability steward, construction manager (design-build),
- Global practice and mobility: mutual recognition agreements (MRAs), international standards of competency (UNESCO-UIA Charter),

Learning Outcomes:

Core:

1. Describe the pathways to architectural registration and licensing in a specific jurisdiction and explain the legal [Familiarity]
2. Apply the AIA, RIBA, or equivalent code of ethics to a practice scenario, identifying ethical dilemmas and appropriate courses of action [Usage]
3. Evaluate a practice model (sole proprietorship, partnership, distributed practice) for its suitability to a specific market, project type, [Assessment]

A.7.2 PRO/Project Delivery Methods and Contracts (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the various methods for delivering architectural projects - design-bid-build, design-build, CM at risk, integrated project delivery - and the standard contracts that govern architect-client and architect-contractor relationships.

Topics:

Core

- Project delivery methods: design-bid-build (DBB), design-build (DB), construction manager at risk (CMAR), integrated project delivery (IPD), and public-private partnership (P3)
- Standard contract forms: AIA A201 (General Conditions), B101 (Owner-Architect), A101 (Owner-Contractor); RIBA Professional Services Contracts; FIDIC Red, Yellow, Silver Books
- Architect's scope of services by phase: pre-design (feasibility), schematic design, design development, construction documents, bidding/negotiation, construction administration
- Design-bid-build in detail: public procurement (lowest qualified bidder, best value), prequalification of contractors, bid documents, addenda, bid alternates,
- Integrated project delivery and relational contracting: IPD multiparty agreement, risk/reward sharing, lean construction principles, and BIM execution plans as contract exhibits. See also: BIM Standards, Policy, and Contracts

Learning Outcomes:

Core:

1. Describe the three primary project delivery methods - design-bid-build, design-build, and integrated project delivery - and explain the architect's role and liability in each [Familiarity]
2. Select an appropriate project delivery method for a given project type (public school, private office, design-build for fast-track) [Usage]
3. Evaluate a completed project's delivery method for efficiency, cost control, and design quality, identifying contractual provisions that contributed to or hindered success [Assessment]

A.7.3 PRO/Project Management and Construction Economics (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers project management methods for architects: scope, schedule, budget, quality, and risk management; cost estimation, value engineering, and construction economics.

Topics:

Core

- Project management phases: initiation, planning, execution, monitoring/controlling, close-out; work breakdown structure (WBS), Gantt charts, critical path method (CPM),
- Cost estimation methods: order-of-magnitude, schematic, design development, and construction document estimates
- Value engineering (VE) in architecture: function analysis, cost-performance trade-offs, life cycle costing

- Risk management for architectural projects: identifying design risks (code compliance, constructability), professional liability risks (errors and omissions),
- Construction specifications: MasterFormat divisions (CSI), section organization (part 1: general, part 2: products, part 3: execution)
- Construction quality management: quality plans and inspection/test plans (ITPs) aligned with ISO 9001, non-conformance reports (NCRs) and corrective actions, and compilation of the quality dossier (material certifications, test reports, inspection records, as-built verification) for project close-out

Learning Outcomes:

Core:

1. Describe the key project management activities for an architectural project: scheduling, cost estimating, value engineering, risk management, and quality management, [Familiarity]
2. Prepare a project schedule (Gantt chart) for a design project, linking deliverables to phases, and produce a schematic-level cost estimate using assembly-based unit costs [Usage]
3. Evaluate a project's budget and schedule performance against the baseline, using earned value management (EVM) metrics to identify cost or schedule overruns [Assessment]

A.7.4 PRO/Collaborative and Interdisciplinary Practice (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the methods and tools for effective collaboration with engineers, consultants, contractors, and clients: integrated practice, BIM collaboration, lean construction, and interdisciplinary team dynamics.

Topics:

Core

- Integrated practice (IP): the architect as part of a multi-disciplinary team (structural, MEP, civil, landscape, acoustics, lighting, sustainability)
- BIM collaboration: federated models, clash detection and resolution, model-based quantity takeoff for estimating, from the collaborative-practice side. See also: Collaborative BIM Workflows
- Lean construction principles: pull planning, last planner system, reducing waste (waiting, defects, overproduction), continuous improvement (PDCA),
- Interdisciplinary communication and conflict resolution: RFI (request for information) and submittal processes, design review meetings,
- Collaborative client engagement: design charrettes, value alignment workshops, and the use of virtual reality (VR)

Learning Outcomes:

Core:

1. Describe the roles of the primary consultants (structural, MEP, civil, landscape) in an architectural project and explain how collaboration is structured in integrated practice [Familiarity]
2. Develop a BIM collaboration protocol for a project, specifying model sharing standards, clash detection frequency, meeting rhythms, [Usage]
3. Evaluate a project's interdisciplinary collaboration process for effectiveness, identifying coordination breakdowns (e.g., unresolved clashes, late RFIs) [Assessment]

A.7.5 PRO/Ethics, Decolonial Practice, and Social Responsibility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the ethical obligations of architects: public health, safety, and welfare; professional integrity; environmental stewardship; decolonial practice; and social responsibility as a designer of the built environment.

Topics:

Core

- Codes of ethics: AIA Code (Canons: protect the public, serve clients, maintain integrity, advance the profession), RIBA Code of Conduct,

- Public health, safety, and welfare (PHSW): building safety, accessibility, fire life safety, structural integrity, and indoor air quality as primary ethical duties
- Environmental ethics: professional responsibility for embodied carbon reduction, circular material use, climate design,
- Decolonial professional practice: critically examining colonial legacies in architectural practice (land dispossession, cultural erasure)
- Social architecture and humanitarian practice: pro bono services, community design centers, post-disaster reconstruction,

Learning Outcomes:
Core:

1. Describe the core ethical principles that govern architectural practice - public health and safety, environmental stewardship, decolonial engagement, [Familiarity]
2. Apply a code of ethics to a professional dilemma (e.g., client request for non-code-compliant solution, conflict of interest, cultural appropriation of traditional forms) [Usage]
3. Evaluate an architectural practice's ethical performance using criteria derived from professional codes, decolonial and environmental ethics frameworks, [Assessment]

A.7.6 PRO/Business of Architecture and Entrepreneurship

Covers the business and entrepreneurial aspects of architectural practice: firm formation, financial management, business development, marketing, and emerging models of practice (start-up, product design, development).
Topics:
Non Core

- Architectural firm management: business structures (sole proprietorship, LLC, corporation), financial management (overhead, billable rates, utilization rate, profit margin),
- Fee structures and negotiation: hourly, percentage of construction cost, lump sum, and design-build fees; calculating multiplier and break-even rate
- Business development and marketing: identifying target project types, proposal writing, interview preparation, client relationship management (CRM),
- Entrepreneurial architecture: product-based practice (design-build of prefab units, furniture, components), architect as developer, start-up models (co-working, remote practice)
- Intellectual property in architecture: copyright ownership of architectural works (US Copyright Act, Berne Convention), licensing of drawings and digital models, moral rights,

Learning Outcomes:
NonCore:

1. Identify the key financial metrics of architectural practice (utilization rate, multiplier, break-even rate) and describe common fee structures and their risks and benefits [Familiarity]
2. Prepare a simple business plan for a hypothetical architectural firm, including target markets, fee strategy, staffing plan, and financial projections for the first three years [Usage]
3. Evaluate a firm's financial performance using P&L statements, balance sheets, and KPI benchmarks from AIA or RIBA business surveys [Assessment]

A.7.7 PRO/Future of the Profession: AI and New Roles

Covers the transformation of architectural practice driven by artificial intelligence, automation, new business models, and the evolution of the architect's role in a technology-intensive future.
Topics:
Non Core

- AI in architectural practice: generative design (text-to-3D, image-to-3D), AI-assisted planning code compliance, automated clash detection,
- BIM automation and scripting: automating repetitive tasks (door and window schedules, room data sheets), generative layout for bathrooms and parking, framed as a future-of-practice trend. See also: AI-Assisted BIM Automation
- New practice models enabled by digital tools: platform-based design (remote delivery), fractional architect services, on-demand expertise via marketplaces,

- Skills and competencies for the future architect: data literacy, computational design, AI prompt engineering, cross-disciplinary collaboration,
- Ethical and legal implications of AI in practice: authorship and copyright of AI-generated designs, liability for AI-assisted errors,

Learning Outcomes:
NonCore:

1. Describe the potential impacts of generative AI and automation on architectural workflows, including tasks that are likely to be automated, augmented, or newly created [Familiarity]
2. Design a future practice model (solo, small firm, or platform-based) that leverages AI and automation to deliver architectural services more efficiently while maintaining design [Usage]
3. Evaluate an AI tool or service marketed to architects for its actual impact on design quality, error reduction, [Assessment]

A.8 Architectural Representation and Digital Tools (REP)

Architectural Representation and Digital Tools covers the visual and computational languages through which architects conceive, develop, and communicate spatial ideas. It spans traditional orthographic drawing, 3D modeling, parametric design, simulation, extended reality, and generative AI. Students develop fluency in a range of media and learn to select the appropriate representation tool for each design phase and audience. BIM authoring and execution planning are covered in depth in the dedicated BIM knowledge area (see BIM Fundamentals and Authoring, BIM Execution Planning and Standards).

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.8.1 Orthographic Drawing and Conventions (Pg.. 247)	1	1
⭐ A.8.2 Computer-Aided Drafting (CAD) (Pg.. 248)	1	1
⭐ A.8.3 Graphic Symbols and Drafting Conventions (Pg.. 248)	1	1
⭐ A.8.4 Three-Dimensional Modeling (Pg.. 249)	1	1
⭐ A.8.5 Architectural Communication and Presentation (Pg.. 249)	1	1
⭐ A.8.6 Parametric Design and Visual Programming (Pg.. 250)	1	1
⭐ A.8.7 Simulation and Performance Analysis (Pg.. 250)	1	1
A.8.8 Augmented, Virtual, and Mixed Reality (XR) (Pg.. 251)	Elective	
⭐ A.8.9 Generative AI for Architectural Design (Pg.. 251)	1	1
A.8.10 Digital Fabrication Output and CNC Toolpaths (Pg.. 252)	Elective	

Table A.8: List of KUs in the Architectural Representation and Digital Tools area.

A.8.1 REP/Orthographic Drawing and Conventions (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the conventions of orthographic, paraline, and perspective architectural drawing: plans, sections, elevations, axonometrics, isometric projections, and one/two/three-point perspective; freehand sketching and diagrammatic schemas as an interpretive counterpart to measured hard-line drawing; line weights, graphic scales, annotation, and drawing organization for communication.
Topics:
Core

- Orthographic projections: plan (cut plane at typical eye level or 1.5 m), section (cut through building, showing structure and spatial relationship), elevation (external
- Paraline drawings: isometric (equal angles, true scale), axonometric (plan oblique, elevation oblique), and their use in showing spatial depth without perspective distortion
- Perspective (conic projection) drawing: one-, two-, and three-point perspective construction, vanishing points, horizon line, and station point – the convergent-projection family used for experiential and presentation views, as distinct from the parallel-projection conventions of orthographic and paraline drawing

- Freehand architectural sketching and schematic diagrams: quick observational sketches and on-site architectural studies ("apuntes") to record buildings and spaces, line quality and proportion by eye, light tonal shading, and parti, bubble, and concept diagrams as a loose, interpretive mode of representation distinct from measured hard-line drawing
- Line weight conventions: hierarchy of outline, section cut, foreground, middle ground, background, and hidden lines
- Drawing set organization: title block, sheet numbering, drawing index; relationship between plans (architectural, structural, MEP, reflected ceiling), elevations, sections,
- Dimensioning and annotation: string dimensions, overall dimensions, grid lines, spot elevations, section marks, finish labels, door and window tags
- Normalization of plan representation: ISO 128 (general principles) and ISO 5455 (scales) as international references; national drawing-set and plan-presentation requirements for permit submission (e.g. Peru's Reglamento Nacional de Edificaciones under Ley 29090)

Learning Outcomes:

Core:

1. Identify the standard orthographic, paraline, and perspective drawing types - plan, section, elevation, axonometric, isometric, one/two/three-point perspective - as well as freehand architectural sketching and diagrammatic schemas, and describe their respective uses [Familiarity]
2. Produce a set of orthographic drawings (plan, section, elevation) for a small building that consistently applies line weight conventions, dimensioning, [Usage]
3. Evaluate a set of architectural drawings for clarity, completeness, and adherence to graphic standards, identifying missing dimensions, inconsistent line weights, [Assessment]

A.8.2 REP/Computer-Aided Drafting (CAD) (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the digital production of 2D architectural drawings in CAD software, as distinct from the hand-drafting and freehand techniques of analog representation.

Topics:

Core

- Digital 2D drafting in CAD software: layer organization and naming conventions (AIA CAD Layer Guidelines, US National CAD Standard), line types and line weights managed by layer, blocks and symbols as reusable CAD objects, external references (Xrefs) for coordinating consultant drawings, and plotting and sheet setup

Learning Outcomes:

Core:

1. Identify the core conventions of digital 2D CAD drafting - layer organization, line types, blocks, and external references - and describe how they differ from hand-drafting conventions [Familiarity]
2. Produce a set of 2D CAD drawings for a small building using organized layers, blocks, and a consistent plotting and sheet setup [Usage]
3. Evaluate a set of CAD drawings for layer organization, line-type consistency, and block usage, identifying errors that would complicate plotting or consultant coordination [Assessment]

A.8.3 REP/Graphic Symbols and Drafting Conventions (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the standardized graphic vocabulary used within architectural drawings: symbols, hatching, and line conventions for architectural elements, furniture and fixtures, building systems (MEP), site/landscape features, signage, and structural components.

Topics:

Core

- Architectural element symbols: door swing and window types in plan, wall representation and hatching by material (concrete, masonry, drywall, wood), and stair/ramp conventions (up/down arrows, break lines, nosing)
- Furniture and fixed-equipment symbols: furniture blocks (seating, tables, beds), kitchen and bathroom fixtures, and standard clearances shown in plan

- Building-systems symbol libraries: electrical symbols (outlets, switches, lighting fixtures, panels) and plumbing/sanitary symbols (fixtures, supply and drainage lines)
- Material hatching and texture conventions in plan and section: concrete, earth, insulation, wood, and stone, and their standard graphic representation
- Landscape and site symbols: planting symbols by canopy size and species type, paving and hardscape textures, and vehicle/parking symbols for site plans
- Signage and wayfinding symbols: accessibility pictograms, means-of-egress and exit signage, and room-numbering conventions
- Structural drawing conventions: column/structural grid notation, beam and slab representation, and reinforcement symbols in structural drawings

Learning Outcomes:

Core:

1. Identify the standard graphic symbols for architectural elements, furniture, building systems (MEP), site/landscape features, signage, and structural components [Familiarity]
2. Apply standard symbol and hatching conventions consistently across a set of architectural drawings, including furniture, MEP, landscape, and structural symbols [Usage]
3. Evaluate a set of architectural drawings for correct and consistent use of graphic symbols and conventions, identifying non-standard or ambiguous symbol use [Assessment]

A.8.4 REP/Three-Dimensional Modeling (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers techniques for creating, editing, and visualizing three-dimensional digital models of buildings and components: solid modeling, surface modeling, and mesh modeling for design exploration and presentation.

Topics:

Core

- Geometric modeling types: solid modeling (extrude, loft, revolve, boolean operations), surface modeling (NURBS, patches), mesh modeling (subdivision)
- Modeling workflows: massing model (initial concept), schematic model (rooms, openings), detailed model (materials, joinery, fixtures),
- 3D rendering for presentation: material assignment (diffuse, roughness, metallic, transparency), lighting setup (directional, point, ambient, HDRI), camera settings (focal length
- UV mapping and texturing: UV coordinates for applying 2D images to 3D surfaces, texture mapping (diffuse, bump, normal, displacement), and avoiding texture stretching and seams
- Interoperability between modeling tools: file formats (OBJ, FBX, STEP, STL, 3MF) and common translation issues (lost geometry, material mapping

Learning Outcomes:

Core:

1. Describe the differences between solid, surface, and mesh modeling and identify the appropriate modeling technique for a given architectural task (massing, detailed component [Familiarity]
2. Create a detailed 3D model of a building component (window, stair, facade panel) using solid modeling operations, then generate a rendered view with materials and lighting [Usage]
3. Evaluate the quality of a 3D model for a specific use (rendering, 3D printing, BIM integration), assessing geometric accuracy, topology cleanliness, and resolution appropriateness [Assessment]

A.8.5 REP/Architectural Communication and Presentation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the effective presentation of architectural ideas to diverse audiences: design boards, slide presentations, portfolios, physical models, and verbal and written communication.

Topics:

Core

- Design boards and panels: composition principles (grid, hierarchy, contrast, white space), integrating drawings (plan, section, elevation, axonometric, perspective), renderings
- Architectural portfolio design: project selection (range of scales, stages, typologies), portfolio structure, narrative, captioning,

- Physical model presentation: material choices (cardboard, foam, acrylic, 3D-printed, laser-cut), scale selection, level of detail, lighting
- Verbal presentation of design: structuring a 5-10 minute design pitch (problem, concept, proposal, testing, conclusion), visual aids, responding to critique,
- Architectural diagramming: circulation, program, structure, environmental performance, form generation, process

Learning Outcomes:

Core:

1. Describe the key elements of effective architectural communication: narrative structure, visual hierarchy, appropriate level of detail, [Familiarity]
2. Produce a design presentation board (single panel) for an architectural project that integrates orthographic drawings, rendered views, diagrams, [Usage]
3. Evaluate a design portfolio or presentation for its communicative effectiveness, identifying strengths in narrative and visual clarity [Assessment]

A.8.6 REP/Parametric Design and Visual Programming (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of visual programming environments (Grasshopper, Dynamo) to create parametric models: associative geometry, data flows, iterative variation, and the integration of parametric design into architectural workflows.

Topics:

Core

- Associative (parametric) modeling: defining geometry through relationships and rules rather than fixed coordinates; data flow graphs (inputs, components, outputs)
- Data types in parametric models: numbers (integers, floats), points, vectors, curves, surfaces, breps, lists, data trees (graft, flatten, simplify),
- Attractors and fields: using point attractors, curve attractors, or image sampling to modulate geometric parameters (size, rotation, density, offset) across a field
- Parametric design families: creating a parameterized component (window, shading louver, structural node) whose geometry updates when driving dimensions or external data changes
- Integrating external data: reading data from CSV/Excel files to drive geometry (site sun hours, program areas, cost data)

Learning Outcomes:

Core:

1. Describe the principles of associative parametric modeling and explain the role of data trees, attractors, and external data in generating geometric variation [Familiarity]
2. Develop a parametric definition for a building facade panel system or structural grid that varies by orientation or solar exposure [Usage]
3. Evaluate a parametric definition for efficiency and clarity, identifying unnecessary components, redundant data structures, and opportunities for simplification or documentation [Assessment]

A.8.7 REP/Simulation and Performance Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of simulation tools integrated with architectural modeling to evaluate environmental performance: daylight, energy, thermal comfort, solar radiation, and airflow.

Topics:

Core

- Daylight simulation workflows: importing geometry into Radiance-based tools (DIVA, ClimateStudio), setting materials (reflectance, transmittance), defining sky models (overcast
- Energy modeling workflows: setting up geometry in OpenStudio/EnergyPlus or IES VE, defining construction assemblies (U-value, SHGC), schedules, internal loads, HVAC systems,
- Solar radiation analysis: calculating incident solar radiation on building surfaces (facade, roof, ground) using Ladybug or ClimateStudio

- Thermal comfort simulation: PMV (predicted mean vote) and adaptive comfort models in EnergyPlus; natural ventilation modeling
- Computational fluid dynamics (CFD) for architecture: simplified (zonal) vs. detailed (RANS, LES) airflow simulation

Learning Outcomes:
Core:

1. Describe the main simulation types - daylight, energy, solar radiation, thermal comfort, and airflow - [Familiarity]
2. Perform a daylight simulation for a building facade using a climate-based model, interpreting sDA and ASE results to adjust aperture size, WWR, or shading [Usage]
3. Evaluate a simulation report for a building design, identifying unrealistic inputs (e.g., overly optimistic plug loads, missing shading) [Assessment]

A.8.8 REP/Augmented, Virtual, and Mixed Reality (XR)

Covers the use of extended reality technologies in architecture: virtual reality (VR) for design immersion and review, augmented reality (AR) for on-site overlay, and mixed reality (MR) for collaborative design.
Topics:
Non Core

- Virtual reality for architectural design: immersive walkthroughs, scale verification, lighting and material perception, and the use of VR for client presentations
- Augmented reality for construction and on-site coordination: overlaying BIM models onto physical construction via tablets or AR glasses (HoloLens)
- Mixed reality for collaborative design: multi-user shared virtual environments, real-time sketching and model manipulation across remote locations,
- XR workflow integration: exporting models from Revit, Rhino, or SketchUp to VR platforms (Enscape, Twinmotion, Unreal Engine), optimization for real-time performance (LOD
- Usability and ethical considerations in XR for architecture: cybersickness, accessibility for users with disabilities, data privacy in shared virtual spaces,

Learning Outcomes:
NonCore:

1. Describe the differences between virtual reality (VR), augmented reality (AR), and mixed reality (MR), [Familiarity]
2. Set up a VR walkthrough of an architectural model using a real-time rendering engine, optimizing the model for performance and evaluating the design at 1:1 scale in immersive mode [Usage]
3. Evaluate the usability of an AR or VR application for a specific architectural task (client presentation, design review, construction QA), identifying technical limitations [Assessment]

A.8.9 REP/Generative AI for Architectural Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of generative AI (text-to-image, image-to-image, and text-to-3D) in architectural design ideation, concept development, and visual communication.
Topics:
Core

- Text-to-image generation for design ideation: prompt engineering (style descriptors, architectural typologies, atmospheric qualities), iterative refinement,
- Image-to-image and inpainting: using sketches or massing models as input for AI refinement (style transfer, detail generation)
- Emerging text-to-3D generation: generating 3D models (mesh, point cloud, NeRF) from text or image prompts
- Integrating generative AI into architectural workflows: early concept generation, client mood boards, presentation image enhancement (style transfer, background replacement
- Limitations and risks of generative AI in architecture: lack of dimensional accuracy, non-constructible details, copyright

Learning Outcomes:
Core:

1. Describe the capabilities and limitations of generative AI (text-to-image, image-to-image, text-to-3D) for architectural design ideation and visual communication [Familiarity]
2. Use a text-to-image AI tool to generate a set of conceptual design variations for an architectural project, then refine the best variation through image-to-image inpainting [Usage]
3. Evaluate AI-generated design images for their applicability to a real design problem, distinguishing inspirational material from constructible design content, [Assessment]

A.8.10 REP/Digital Fabrication Output and CNC Toolpaths

Covers the translation of digital models to physical artifacts: generating toolpaths for CNC routers, laser cutters, 3D printers, and robotic arms; material constraints; and post-processing.
Topics:
Non Core

- CNC milling workflow: generating toolpaths from 3D models (roughing and finishing passes), selecting bits (end mill, ball nose), setting feeds and speeds, workpiece fixturing,
- Laser cutting workflow: preparing vector files (DXF, AI), setting cut vs. etch parameters by material type (plywood, acrylic, cardboard), kerf compensation,
- 3D printing workflow: STL/3MF file preparation, orientation for minimal supports, layer height, infill density, print bed adhesion,
- Robotic fabrication basics: 6-axis robotic arm kinematics, toolpath generation (KUKA|prc, HAL for Grasshopper), end-effector design (spindle, extruder, gripper),
- Post-processing of digitally fabricated parts: removing supports, sanding, painting, assembly of modular components, and the relationship between fabrication tolerances

Learning Outcomes:
NonCore:

1. Describe the workflows for CNC milling, laser cutting, and 3D printing in architectural model-making and prototyping, including file preparation, machine parameter selection, [Familiarity]
2. Generate toolpaths for a laser cutter or CNC router from a 3D model or 2D vector file, fabricate a physical prototype, and document the process [Usage]
3. Evaluate the suitability of a digital fabrication method (CNC, laser, 3D print) for a specific architectural component or model, considering material, resolution, cost, [Assessment]

A.9 Interior Architecture and Space Design (INT)

Interior Architecture and Space Design addresses the design of habitable interior spaces, integrating spatial planning, materials, lighting, acoustics, furniture, and ergonomics. It covers the specific requirements of residential, commercial, healthcare, and institutional interiors, with an emphasis on human experience and well-being. Students learn to design interiors that are functional, beautiful, healthy, and responsive to user needs.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.9.1 Interior Space Planning and Programming (Pg.. 253)	1	1
⭐ A.9.2 Materials, Finishes, and Specifications (Pg.. 253)	1	1
⭐ A.9.3 Furniture, Equipment, and Ergonomics (Pg.. 254)	1	1
⭐ A.9.4 Lighting Design (Pg.. 254)	1	1
⭐ A.9.5 Acoustics in Interior Spaces (Pg.. 254)	1	1
⭐ A.9.6 Universal Design and Accessibility (Pg.. 255)	1	1
A.9.7 Healthcare and Specialized Interiors (Pg.. 255)	Elective	
A.9.8 Sustainable Interior Design (Pg.. 256)	Elective	

Table A.9: List of KUs in the Interior Architecture and Space Design area.

A.9.1 INT/Interior Space Planning and Programming (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the process of programming and planning interior spaces: user requirements, adjacency diagrams, circulation, zoning, and the translation of program into spatial layouts.

Topics:

Core

- Interior programming: user interviews, activity analysis, space adjacency requirements (bubble diagrams), space-by-space criteria (area, finishes, lighting, power, data),
- Circulation and zoning in interiors: public vs. private, quiet vs. active zones, service vs. served spaces, circulation paths (primary, secondary, service),
- Universal interior layout: ADA clear floor space, turning radius, reach ranges, maneuvering clearances at doors, and accessible routes through furniture arrangements
- Space standards by typology: residential (room dimensions, clearance around beds, kitchen work triangle, bathroom fixture spacing), office (workstation size, aisle widths)
- Adaptable and flexible interiors: movable partitions, demountable walls, modular furniture systems, and the design of interior spaces for evolving uses (home-office

Learning Outcomes:

Core:

1. Identify the steps of interior programming and describe how adjacency diagrams, zoning, and circulation analysis inform spatial layouts [Familiarity]
2. Develop an interior space plan for a given program (residential, office, retail) that meets accessibility clearances, circulation needs, and adjacency requirements [Usage]
3. Evaluate an interior layout for efficiency, accessibility, and user satisfaction, identifying pinch points, poor adjacencies, and non-compliant clearances [Assessment]

A.9.2 INT/Materials, Finishes, and Specifications (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the selection and specification of interior finishes and materials: floor, wall, ceiling, countertop, and upholstery materials; performance criteria (durability, cleanability, flammability, VOC); and sustainable material selection.

Topics:

Core

- Flooring materials: carpet (broadloom, tile), resilient (vinyl, linoleum, rubber), wood (solid, engineered, laminate), stone, ceramic tile, concrete, and polished concrete
- Wall and ceiling finishes: paint (sheen types, VOC limits), wallpaper, fabric panels, wood paneling, acoustic panels (fabric-wrapped, perforated wood), and gypsum board
- Countertop and solid surface materials: laminate, solid surface (Corian), quartz, granite, marble, stainless steel, concrete, wood block
- Sustainable interior materials: low-VOC paints and adhesives, rapidly renewable materials (bamboo, cork, linoleum), recycled content (terrazzo, recycled glass, recycled plastic)
- Finish specifications: manufacturer, product name, color, pattern, installation method, and maintenance requirements

Learning Outcomes:

Core:

1. Describe the principal interior finish materials for floors, walls, ceilings, and countertops, and explain their performance characteristics (durability, cleanability [Familiarity]
2. Select and specify interior finishes for a commercial or residential interior, considering use category (office, restaurant, healthcare, residence), maintenance requirements, [Usage]
3. Evaluate a finish schedule for material suitability, code compliance (flammability, slip resistance), and alignment with sustainability goals, proposing substitutions where needed [Assessment]

A.9.3 INT/Furniture, Equipment, and Ergonomics (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the selection, specification, and spatial arrangement of furniture and equipment: ergonomic dimensions, clearance zones, furniture typologies, and casework design.

Topics:

Core

- Human dimensions and ergonomics: anthropometric data (percentiles for seated reach, standing height, clearance), sight lines, reach zones for controls and storage,
- Furniture typologies: seating (task chair, lounge, dining), tables (desk, conference, dining), storage (cabinets, shelving, wardrobe), casework (kitchen
- Furniture space clearances: turning clearances for wheelchairs (1.5 m diameter), clearance under tables for knee and foot space, clear floor space at appliances,
- Millwork and casework design: cabinet construction (framed vs. frameless), door and drawer types, hardware selection, countertop integration,
- Furniture specifications: manufacturer, model number, dimensions, materials, finish, and ergonomic certifications (BIFMA, GREENGUARD); specifying for durability (commercial vs.

Learning Outcomes:

Core:

1. Describe the ergonomic and anthropometric principles that determine furniture dimensions and clearances, including reach zones, sight lines, and wheelchair accessibility [Familiarity]
2. Produce a furniture layout for an interior space (office, residence, waiting room) that meets circulation clearances, ergonomic reach standards, and accessibility requirements [Usage]
3. Evaluate a furniture plan for ergonomic suitability, accessibility, and functional efficiency, identifying conflicts (pinch points, blocked pathways) and recommending adjustments [Assessment]

A.9.4 INT/Lighting Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design of lighting for interior spaces: daylight integration, electric lighting systems (ambient, task, accent), color temperature, color rendering, lighting controls, and energy-efficient design.

Topics:

Core

- Lighting metrics: illuminance (lux, foot-candle), luminance, color temperature (CCT in Kelvin), color rendering index (CRI), TM-30 (color fidelity and gamut),
- Lighting layers: ambient (general illumination), task (specific work-plane lighting), accent (highlighting art or features), and decorative (focal or mood lighting)
- Types of electric lighting: incandescent, halogen, fluorescent (linear, compact), LED (boards, strips, downlights, track)
- Integration of daylight with electric lighting: daylight harvesting sensors, dimming systems, and control strategies to maintain constant illuminance while reducing energy
- Lighting control systems: occupancy sensors, daylight sensors, timers, programmable scenes, and integration with building automation systems (BAS)

Learning Outcomes:

Core:

1. Describe the metrics of lighting quality (illuminance, CCT, CRI, glare) and the roles of ambient, task, accent, and decorative lighting in interior design [Familiarity]
2. Design a lighting scheme for an interior space, selecting fixture types, positions, and controls to meet illuminance targets for each task zone while achieving energy efficiency [Usage]
3. Evaluate a lighting design for visual comfort, energy use, and task suitability, identifying potential glare issues or insufficient illumination for specific activities [Assessment]

A.9.5 INT/Acoustics in Interior Spaces (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the acoustic design of interior spaces: sound absorption, sound isolation, reverberation control, privacy, and acoustic finishes for offices, classrooms, healthcare, and performance spaces.

Topics:

Core

- Reverberation control: calculating RT60 from room volume and total absorption; selecting absorptive materials (fiberglass panels, fabric-wrapped panels, acoustic foam
- Sound isolation between interior spaces: STC ratings for partitions (wall, floor-ceiling), flanking paths (ducts, plenums, electrical outlets),
- Speech privacy in open-plan and shared offices: sound masking (white noise) systems, partial-height partitions, absorptive ceilings, and the Articulation Index (AI)
- Interior noise control: HVAC noise criteria (NC curves), plumbing noise (water hammer, drain noise), footfall impact noise (IIC rating of floor finishes, underlayments),
- Acoustic finish specification: NRC (noise reduction coefficient) and SAA (sound absorption average) ratings

Learning Outcomes:
Core:

1. Describe the acoustic metrics (RT60, STC, IIC, NRC) and explain how they guide the selection of interior finishes and partition construction for different room uses [Familiarity]
2. Design an acoustic treatment plan for an interior space (classroom, open office, conference room) specifying absorptive panel placement, ceiling treatment, [Usage]
3. Evaluate an interior space for acoustic performance, identifying excessive reverberation, poor sound isolation, or noise intrusion, and proposing finish or partition modifications [Assessment]

A.9.6 INT/Universal Design and Accessibility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers universal design principles and accessibility standards for interior spaces: equitable use, flexibility, simple and intuitive operation, perceptible information, tolerance for error, low physical effort, and size and space for approach and use.
Topics:
Core

- ADA Standards for Accessible Design for interiors: accessible routes (width, slope, passing spaces), door maneuvering clearances, turning spaces, reach ranges,
- Applying the 7 principles of universal design: equitable use (entrance and circulation for all), flexibility in use (left- and right-handed operation), simple
- Adaptable and visitable housing: adaptable units for aging-in-place (reinforced bathroom walls for future grab bars, wider doorways, zero-step entries)
- Interior wayfinding for diverse users: color contrast for low vision, tactile signage (Braille, raised letters), audible information (voice announcements),
- Sensory design for neurodiverse and low-sensory users: acoustic zoning (quiet rooms), lighting that avoids flicker and glare, odor control,

Learning Outcomes:
Core:

1. Describe the ADA Standards for accessible interior spaces (clear floor space, reach ranges, turning radius, door clearances) and the 7 principles of universal design [Familiarity]
2. Design an accessible interior layout (restaurant, office, residence) that meets ADA clearances for circulation, doors, restrooms, and accessible counters or work surfaces [Usage]
3. Evaluate an interior design for compliance with universal design principles, identifying barriers to access for users with mobility, vision, hearing, or cognitive impairments [Assessment]

A.9.7 INT/Healthcare and Specialized Interiors

Covers the design of specialized interior environments: healthcare facilities (hospitals, clinics, dental offices, laboratories), clean rooms, and other controlled environments, with emphasis on infection control, patient safety, and staff well-being.
Topics:
Non Core

- Hospital interior design: patient room layout (clearances, family zone, caregiver zone, headwall design), infection control finishes (seamless, antimicrobial, easy-clean)
- Clinical area interiors: exam rooms (hand sink, storage, work counter), nurse stations (sight lines to patient rooms), medication rooms (security, temperature control),

- Behavioral and mental health interiors: ligature-resistant design (no hanging points, tamper-proof fixtures), safety glazing, continuous flooring, sloped ceilings over beds,
- Laboratory and clean room interiors: non-porous, chemical-resistant surfaces, air filtration (HEPA/ULPA), pressure differentials (positive vs.
- Evidence-based design for healthcare interiors: patient falls reduction (flooring, lighting, handrails), staff fatigue reduction (access to daylight, break areas),

Learning Outcomes:
NonCore:

1. Identify the specialized design requirements for healthcare interiors: infection control finishes, patient safety (ligature resistance, fall prevention), [Familiarity]
2. Design a patient room or clinical exam room layout that meets infection control standards, safety requirements, and clinical workflow needs, specifying finishes, fixtures, [Usage]
3. Evaluate a healthcare interior design for patient safety, infection control, and staff efficiency, identifying risks and proposing evidence-based modifications [Assessment]

A.9.8 INT/Sustainable Interior Design

Covers sustainable interior design strategies: material health, indoor environmental quality, energy and water efficiency, waste reduction, and certification frameworks (LEED ID+C, WELL, RESET).
Topics:
Non Core

- Material health in interiors: Red List ingredients to avoid (phthalates, formaldehyde, halogenated flame retardants), Declare labels (Living Building Challenge)
- Indoor environmental quality (IEQ) in interiors: low-VOC finishes, particle filtration (MERV 13), CO_2 monitoring, thermal comfort zoning, daylight access, and acoustic privacy
- Sustainable furniture and waste reduction: specifying reused and refurbished furniture, design for disassembly (reversible connections, standardized parts), take-back programs
- LEED Interior Design and Construction (ID+C) credits: low-emitting materials, daylight, quality views, acoustic performance, and material optimization
- Circular interior design: adaptable wall systems for reconfiguration without demolition, standardized modular furniture that can be re-allocated

Learning Outcomes:
NonCore:

1. Describe the key frameworks for sustainable interior design: LEED ID+C, WELL, and Living Building Challenge, and their requirements for material health [Familiarity]
2. Specify a set of interior finishes and furniture for a commercial fit-out that meets LEED ID+C low-emitting materials credit, selecting products with HPDs and Declare labels [Usage]
3. Evaluate an interior design project for compliance with sustainable interior criteria, identifying material red-list ingredients, poor IEQ strategies [Assessment]

A.10 Heritage Conservation and Restoration (HER)

Heritage Conservation and Restoration addresses the ethical, technical, and procedural frameworks for preserving and adapting historic buildings and sites. It covers conservation philosophy, documentation and surveying, structural assessment, restoration techniques, and adaptive reuse. Students learn to intervene on historic fabric with intellectual rigor, technical competence, and cultural sensitivity. Heritage BIM (HBIM) and digital twins for conservation are covered in depth in the dedicated BIM knowledge area (see Heritage BIM (HBIM)).

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.10.1 Theory and Philosophy of Conservation (Pg.. 257)	1	1
⭐ A.10.2 Historic Documentation and Digital Survey (Pg.. 257)	1	1
⭐ A.10.3 Structural Assessment of Historic Buildings (Pg.. 258)	1	1
⭐ A.10.4 Restoration and Consolidation Techniques (Pg.. 258)	1	1
⭐ A.10.5 Adaptive Reuse and Building Transformation (Pg.. 259)	1	1
A.10.6 Landscape and Urban Heritage (Pg.. 259)	Elective	
A.10.7 Intangible Heritage and Living Traditions (Pg.. 260)	Elective	

Table A.10: List of KUs in the Heritage Conservation and Restoration area.

A.10.1 HER/Theory and Philosophy of Conservation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the philosophical foundations of architectural conservation: authenticity, integrity, minimal intervention, reversibility, and the charters that codify conservation practice.

Topics:

Core

- Historic conservation charters: Venice Charter (1964) - principles of minimum intervention, reversibility, anastylosis
- Philosophical debate in conservation: Ruskin's anti-restoration (building as ruin), Viollet-le-Duc's stylistic restoration (unity of style), Morris
- Core conservation principles: minimum intervention, reversibility, distinguishability of new work, compatibility of materials, documentation,
- Values-based conservation: assigning values (historic, aesthetic, social, scientific, economic) and managing change through a conservation management plan
- Authenticity and integrity: authenticity of form, material, design, setting, and use; integrity as the intactness of the historic resource
- Peru's Ley 28296 (Ley General del Patrimonio Cultural de la Nación): legal protection of heritage-declared buildings and sites, and the Ministerio de Cultura's authorization requirements for interventions on protected fabric

Learning Outcomes:

Core:

1. Describe the key conservation charters (Venice, Burra, Nara) and their principles: minimum intervention, reversibility, authenticity, and cultural significance [Familiarity]
2. Apply a values-based conservation framework to a historic building or site, identifying its cultural, historic, and social values [Usage]
3. Critically evaluate a conservation intervention proposal against the principles of the Venice and Burra Charters, assessing it for reversibility, compatibility, [Assessment]

A.10.2 HER/Historic Documentation and Digital Survey (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the methods for documenting historic buildings and sites: measured drawing, photogrammetry, laser scanning, and the use of digital survey data for conservation planning and monitoring.

Topics:

Core

- Measured drawing of historic buildings: hand measuring (tape, laser distometer) to produce scaled plans, sections, and elevations
- Close-range photogrammetry: capturing overlapping images, processing with software (Agisoft Metashape, RealityCapture), generating 3D point clouds, meshes,
- Terrestrial laser scanning (TLS): time-of-flight and phase-shift scanners, registration, point cloud processing, and extraction of 2D drawings from 3D point clouds
- Drone-based documentation: aerial photogrammetry and LiDAR for roof, facade, and site topography; flight planning, ground control points (GCPs),

- Condition assessment and monitoring: mapping decay patterns (efflorescence, spalling, cracking, biological growth) on drawings or point clouds

Learning Outcomes:

Core:

1. Describe the principal methods for documenting historic buildings - measured drawing, photogrammetry, laser scanning, and drone survey - and their appropriate scales [Familiarity]
2. Produce measured drawings of a historic building or element using hand measurement, photogrammetry, or point cloud extraction, noting areas of material decay [Usage]
3. Evaluate a documentation survey plan for a historic building, assessing the choice of method (photogrammetry vs [Assessment]

A.10.3 HER/Structural Assessment of Historic Buildings (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the methods for assessing the structural condition of historic buildings: non-destructive testing, monitoring, structural modeling, and diagnosis of decay mechanisms.

Topics:

Core

- Non-destructive testing (NDT) for heritage: rebound hammer, ultrasonic pulse velocity (UPV), moisture meters, endoscopy, thermal imaging,
- Small-sample and minimally invasive testing: core sampling for compressive strength, mortar analysis (chemical composition, binder/aggregate ratio), timber dendrochronology,
- Structural monitoring of historic buildings: crack monitoring (glass telltales, mechanical gauges, electronic displacement sensors), tilt meters,
- Structural modeling for heritage: interpreting historic construction techniques (masonry vaults, timber frames, iron elements), simplified analysis (limit state for masonry),
- Decay mechanisms in historic structures: differential settlement, thrust from vaults, water ingress (freeze-thaw, salt crystallization), timber decay (rot, insect attack),

Learning Outcomes:

Core:

1. Describe the principal non-destructive testing methods for historic building assessment and identify the decay mechanisms commonly found in historic masonry, timber, [Familiarity]
2. Develop a structural assessment plan for a historic building, selecting appropriate NDT and monitoring methods based on materials, decay patterns, and suspected failure mechanisms [Usage]
3. Evaluate the structural condition of a historic building from monitoring data and on-site observations, diagnosing the likely causes of cracking or deformation [Assessment]

A.10.4 HER/Restoration and Consolidation Techniques (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the practical techniques for repairing and consolidating historic materials: masonry repointing, stone consolidation, timber repair, plaster restoration, and the use of compatible, reversible repair methods.

Topics:

Core

- Masonry repair and repointing: lime mortars vs. cement mortars (compatibility, porosity, strength), aggregate selection, repointing profiles (flush, recessed, tuckpointing),
- Stone consolidation: application of consolidants (ethyl silicate, nanolime, acrylic resins) for weathered stone, risks of surface crust formation,
- Timber structural repair: dry rot and wet rot treatment, epoxy consolidation (injections, cast replacements), sistering and splicing,
- Plaster and stucco restoration: lime plaster mix design, hair reinforcement (goat, horse, synthetic), decorative plaster repair (molding, running),
- Metal and glass restoration: wrought and cast iron repair (welding vs. splicing, corrosion protection), stained glass conservation (lead came repair, edge bonding

Learning Outcomes:
Core:

1. Describe the appropriate repair techniques for historic masonry, stone, timber, and plaster, and explain the importance of material compatibility [Familiarity]
2. Specify a repair method for a damaged historic building element (masonry crack, decayed timber, spalled stone), justifying material choice, application sequence, and reversibility [Usage]
3. Evaluate a proposed restoration specification for a historic fabric repair, assessing it for compatibility, reversibility, minimal intervention, [Assessment]

A.10.5 HER/Adaptive Reuse and Building Transformation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design strategies and technical challenges of adapting historic buildings to new uses: building transformation, addition to historic structures, interior retrofitting, and the reconciliation of conservation with contemporary program.
Topics:
Core

- Adaptive reuse strategies: conversion of industrial buildings (warehouse, factory, mill) to residential, office, or cultural use; religious buildings to community space
- Designing additions to historic buildings: approach of contrast (Neue Nationalgalerie, Kolumba Museum) vs.
- Interior adaptation of heritage buildings: inserting new floors and mezzanines, glazed interior partitions for program separation without structural change, MEP
- Material reuse in adaptation: salvaged timber, brick, stone, and fixtures as design features; sourcing from deconstruction
- Code compliance in heritage adaptation: equivalency provisions (IBC Chapter 34, existing buildings), alternative means and methods, structural upgrades for seismic,

Learning Outcomes:
Core:

1. Describe the principal strategies for adaptive reuse of industrial, religious, and infrastructural heritage [Familiarity]
2. Develop an adaptive reuse proposal for a historic building, including program analysis, insertion strategy (interior interventions, addition), [Usage]
3. Evaluate an adaptive reuse project for its success in balancing heritage conservation with new program requirements, assessing the reversibility [Assessment]

A.10.6 HER/Landscape and Urban Heritage

Covers the conservation of designed landscapes, historic gardens, and urban heritage: cultural landscapes, historic urban landscapes (HUL) approach, and the integration of landscape and building conservation.
Topics:
Non Core

- Cultural landscape categories: designed landscapes (historic gardens, parks), vernacular landscapes (agricultural, pastoral), associative landscapes (sacred sites)
- Historic garden and designed landscape conservation: ICOMOS-IFLA Florence Charter (1981), restoration vs.
- Historic Urban Landscape (HUL) approach: UNESCO recommendation (2011), viewing urban heritage as a layered ensemble of built form, open space, infrastructure, social practices
- Landscape character assessment for heritage: identifying historic landscape character types, mapping features,
- Managing the setting of heritage assets: buffer zones, views and vistas (protected views, landmark sightlines), and the design of new interventions to protect the visual

Learning Outcomes:
NonCore:

1. Describe the categories of cultural landscapes and explain the Historic Urban Landscape (HUL) approach to managing change in historic city centers [Familiarity]
2. Develop a landscape conservation plan for a historic garden or park, specifying approaches to plant replacement, path repair, [Usage]
3. Evaluate a development proposal within the setting of a heritage building or conservation area for its impact on historic landscape character, views, [Assessment]

A.10.7 HER/Intangible Heritage and Living Traditions

Covers the conservation of intangible cultural heritage associated with the built environment: traditional building crafts, construction rituals, oral histories, and the role of living communities in place-based heritage.

Topics:

Non Core

- Intangible cultural heritage in architecture: traditional building knowledge (mortar mixing, stone carving, timber joinery), construction rituals (foundation ceremonies
- Safeguarding traditional building crafts: apprenticeship programs, craft documentation (video, manuals, oral histories)
- Living heritage approach: buildings and places that are actively used and maintained by communities through traditional practices (temples, mosques, indigenous longhouses)
- Community engagement in intangible heritage: oral history interviews for place-based memory, participatory mapping of intangible values,
- UNESCO Convention for the Safeguarding of Intangible Cultural Heritage (2003): domains (oral traditions, performing arts, social practices, knowledge of nature

Learning Outcomes:

NonCore:

1. Describe the concept of intangible cultural heritage as it relates to the built environment - traditional building crafts, rituals, and oral histories - [Familiarity]
2. Develop a safeguarding plan for a traditional building craft or construction practice, including documentation, apprenticeship training, [Usage]
3. Evaluate a heritage conservation project for its engagement with intangible values, assessing community participation, respect for traditional knowledge, [Assessment]

A.11 Landscape Architecture (LAN)

Landscape Architecture addresses the design of exterior space as a discipline that integrates ecology, hydrology, horticulture, landform, and human use. It covers landscape design principles, planting design, grading and drainage, landscape materials, green infrastructure, climate-responsive landscape, and ecological restoration. Students learn to shape the land in ways that are ecologically sound, socially engaging, and aesthetically rich.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.11.1 Landscape Design Principles and Process (Pg.. 261)	1	1
⭐ A.11.2 Plants, Ecology, and Ecosystem Services (Pg.. 261)	1	1
⭐ A.11.3 Landform, Hydrology, and Grading (Pg.. 262)	1	1
⭐ A.11.4 Landscape Materials and Construction (Pg.. 262)	1	1
⭐ A.11.5 Urban Landscape and Green Infrastructure (Pg.. 263)	1	1
⭐ A.11.6 Climate-Responsive Landscape Design (Pg.. 263)	1	1
A.11.7 Ecological Restoration and Nature-Based Solutions (Pg.. 264)	Elective	
A.11.8 Landscape at Regional and Territorial Scale (Pg.. 264)	Elective	

Table A.11: List of KUs in the Landscape Architecture area.

A.11.1 LAN/Landscape Design Principles and Process (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the foundational principles of landscape design: site analysis, circulation and spatial organization, view analysis, and the design process from concept to construction documentation.

Topics:

Core

- Site analysis for landscape: topography (slope, aspect), soils (texture, drainage, fertility), hydrology (surface flow, groundwater, flood zones), vegetation, microclimate (sun
- Spatial organization in landscape design: rooms (outdoor rooms), edges (soft vs. hard), sequence (entry, discovery, culmination), focal points (gazebo, sculpture, specimen tree)
- Circulation in landscape: primary (vehicular, bike), secondary (pedestrian), service (maintenance), accessible routes (ADA gradients, surface firmness),
- Landscape architectural drawing: site plans, grading plans, planting plans, irrigation plans, construction details (walls, paving, water features),
- View analysis and visual impact: key views (from building, from approach), framed views, borrowed views, screening of undesirable views, and the use of massing

Learning Outcomes:

Core:

1. Describe the elements of landscape site analysis and the spatial organization principles of outdoor rooms, edges, and circulation [Familiarity]
2. Produce a landscape design concept for a small site, integrating site analysis data into a spatial layout with defined outdoor rooms, circulation, and focal points [Usage]
3. Evaluate a landscape design for its responsiveness to site conditions (topography, hydrology, vegetation) and user needs, identifying strengths and weaknesses in circulation [Assessment]

A.11.2 LAN/Plants, Ecology, and Ecosystem Services (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the ecological foundations of landscape design: plant selection, plant communities, ecosystem services, and the design of resilient, low-input planting that supports biodiversity and climate adaptation.

Topics:

Core

- Plant selection criteria: hardiness zone, soil pH and drainage, light requirements, mature size, growth rate, maintenance needs,
- Plant community design: succession (pioneer to climax), layered planting (canopy, understory, shrub, herbaceous, groundcover), native vs.
- Ecosystem services from designed landscapes: stormwater infiltration (green infrastructure), air temperature reduction (shade, evapotranspiration), carbon sequestration
- Green roofs and living walls: extensive vs. intensive green roofs, substrate depth, plant selection (sedum, grasses, wildflowers), irrigation, structural loading,
- Water-wise planting: xeriscaping principles (hydrozoning, low-water plants, efficient irrigation), drought-tolerant species selection, rain gardens,

Learning Outcomes:

Core:

1. Describe the criteria for plant selection in designed landscapes and explain the principles of plant community design, including layering, succession, and native vs [Familiarity]
2. Design a planting plan for a site that integrates native plant communities, provides ecosystem services (stormwater, habitat, cooling), and meets aesthetic and maintenance goals [Usage]
3. Evaluate a landscape planting plan for ecological performance, including plant diversity, water demand, invasive species risk, and potential to support local pollinators [Assessment]

A.11.3 LAN/Landform, Hydrology, and Grading (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the manipulation of landform for drainage, accessibility, and site aesthetics: grading design, stormwater management, erosion control, and the relationship between landform and hydrology.
Topics:
Core

- Grading design principles: spot elevations, contours, slopes (minimum 1-2% for surface drainage, accessible max 1:12 ramp, 2:1 vegetated slope), cut-and-fill balancing,
- Stormwater management in landscape: runoff calculation (rational method, time of concentration), infiltration basins, rain gardens, bioswales, permeable pavement (porous asphalt
- Erosion and sediment control: silt fences, erosion control blankets, check dams, temporary seeding, and the design of slopes to prevent rill and gully erosion during
- Landform design: using grading to create outdoor rooms, enhance views, provide wind breaks, collect sun, and reduce noise
- Retention and detention basins: wet ponds (retention) for water quality, dry detention basins for peak flow attenuation, forebays for sediment capture,

Learning Outcomes:
Core:

1. Describe the principles of grading design - slopes, cut and fill, and surface drainage - and explain how landscape grading manages stormwater through swales, basins, [Familiarity]
2. Produce a grading and drainage plan for a site, including contour modifications, stormwater management features (bioswale, rain garden), and erosion control measures [Usage]
3. Evaluate a site grading and drainage design for its effectiveness in managing stormwater runoff, preventing erosion, and meeting accessibility slope requirements [Assessment]

A.11.4 LAN/Landscape Materials and Construction (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the materials used in landscape construction: paving, walls, fences, decks, and edging; material selection for durability, aesthetics, permeability, and sustainability.
Topics:
Core

- Paving materials for hardscape: concrete (poured-in-place, pavers, permeable), natural stone (granite, limestone, sandstone), brick, gravel, decomposed granite,
- Retaining wall systems: gravity walls (stone, segmental block), cantilever (reinforced concrete), crib walls, gabion walls, and reinforced soil (geogrid)
- Wood materials in landscape: pressure-treated pine, cedar, redwood, Ipe, and composite lumber (WPC); durability (ground contact rating), rot resistance, fastener selection,
- Edging and site furniture: metal edging (aluminum, steel), plastic, concrete curb, and flexible composite
- Sustainable hardscape materials: recycled content pavers (glass, slag), pervious concrete, reclaimed granite setts, and low-embodied carbon options

Learning Outcomes:
Core:

1. Describe the principal landscape construction materials for paving, retaining walls, wood structures, and site furniture, [Familiarity]
2. Select and detail a landscape paving and retaining wall system for a specific site, specifying materials, base preparation, drainage, and edge restraints [Usage]
3. Evaluate a hardscape specification for material sustainability, permeability, durability in the local climate, [Assessment]

A.11.5 LAN/Urban Landscape and Green Infrastructure (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the integration of landscape and urban systems: green roofs, rain gardens, urban forests, and the design of green infrastructure for stormwater management, heat mitigation, and habitat connectivity.

Topics:

Core

- Green infrastructure types at urban scale: green roofs (extensive, intensive, biodiverse), rain gardens, bioswales, permeable alleys, street tree trenches, constructed wetlands
- Urban forestry: street tree species selection (structural integrity, salt tolerance, root behavior), spacing and placement for shade
- Water-sensitive urban design: integrating stormwater management with landscape aesthetics, water reuse for irrigation,
- Urban heat island mitigation via landscape: cool pavements (high albedo), shading from street trees and green structures, evapotranspirative cooling from green roofs
- Green networks and ecological corridors: connecting parks and open spaces for wildlife movement, integrating greenways along waterways,

Learning Outcomes:

Core:

1. Describe the types of green infrastructure used in urban landscapes - green roofs, rain gardens, bioswales, tree trenches - [Familiarity]
2. Design a green infrastructure intervention for an urban site (plaza, street, rooftop) that manages a specified stormwater volume, reduces surface temperature, and provides amenity [Usage]
3. Evaluate the performance of an existing green infrastructure installation against design goals (stormwater capture, plant survival, user acceptance) [Assessment]

A.11.6 LAN/Climate-Responsive Landscape Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design of outdoor spaces that respond to local climate conditions: wind mitigation, solar shading, thermal comfort in urban canyons, and the use of landscape to create comfortable microclimates.

Topics:

Core

- Microclimate factors in landscape design: solar radiation (orientation, shading), wind speed and direction (prevailing winds, gusty zones), humidity
- Outdoor thermal comfort indices (PET, UTCI), the role of shade (tree canopy, structures) in reducing mean radiant temperature,
- Wind mitigation in landscape: windbreaks (shelterbelts of trees or shrubs), porous fences, the placement of seating and gathering areas in leeward zones,
- Shading design for landscapes: tree placement to shade buildings (winter solar gain vs. summer shading), shading of outdoor seating areas (pergolas, sail shades, umbrellas),
- Seasonal landscape design: winter sun access to windows and seating, summer shading of paved areas, spring and fall wind protection,

Learning Outcomes:

Core:

1. Describe the microclimate factors that affect outdoor thermal comfort and explain how landscape elements - shade, windbreaks, water - can modify them [Familiarity]
2. Design an outdoor seating or gathering space that uses trees, structures, and water features to achieve thermal comfort in a given climate (hot-dry, hot-humid, or temperate) [Usage]
3. Evaluate a landscape design for climate responsiveness, identifying zones of thermal discomfort (glare, wind, excessive sun) and proposing planting or structural modifications [Assessment]

A.11.7 LAN/Ecological Restoration and Nature-Based Solutions

Covers the restoration of degraded landscapes: ecological restoration principles, native species reintroduction, soil remediation, and nature-based solutions for erosion, water quality, and carbon capture.
Topics:
Non Core

- Ecological restoration principles (SER International Standards): reference ecosystem, species composition, structure, function, connectivity, and resilience; passive vs.
- Soil remediation for degraded land: physical (grading, decompaction), chemical (pH adjustment, nutrient addition), biological (mycorrhizal inoculation, compost incorporation),
- Nature-based solutions (NBS) for landscape: constructed wetlands for water treatment, vegetative sand dunes for coastal protection, urban forest for air pollution mitigation,
- Revegetation for restoration: selecting native species adapted to site conditions (wetland, riparian, upland, coastal), seed mixes, planting densities,
- Mine and quarry restoration: regrading of spoil piles, topsoil re-spreading, acid mine drainage treatment (constructed wetlands, lime dosing), and the design of pit lakes

Learning Outcomes:
NonCore:

1. Describe the principles of ecological restoration and the role of nature-based solutions in addressing erosion, water quality, and carbon capture [Familiarity]
2. Develop a restoration plan for a degraded site (former industrial, mined, or agricultural), including soil remediation, species selection, and monitoring protocol [Usage]
3. Evaluate a completed restoration project against SER standards, assessing its success in reestablishing reference ecosystem structure, function, and native species composition [Assessment]

A.11.8 LAN/Landscape at Regional and Territorial Scale

Covers the planning and design of landscape at larger scales: watershed, bioregion, metropolitan area, and megaregion; ecological corridors, green infrastructure networks, and landscape-based planning for climate adaptation.
Topics:
Elective

- Watershed-based landscape planning: hydrologic modeling, riparian buffers, floodplain restoration, and the coordination of land use regulations to protect water quality
- Ecological corridors at regional scale: identifying core habitat patches and connectivity corridors (least-cost path analysis), planning wildlife crossings (overpasses
- Metropolitan green infrastructure: regional park networks, greenways along waterways and rail lines, metropolitan open space plans,
- Bioregional planning: using ecoregions as planning units, integrating agriculture, forestry, and urban development,
- Landscape-based climate adaptation at territorial scale: managing forest fire regimes, planning for sea level rise (managed retreat, dune restoration),

Learning Outcomes:
Elective:

1. Describe the landscape planning scales - watershed, bioregion, metropolitan - and the types of green infrastructure (corridors, buffers, networks) used at each scale [Familiarity]
2. Develop a landscape planning recommendation for a regional-scale issue (wildlife connectivity, flood risk, urban heat) using GIS-based corridor analysis or suitability mapping [Usage]
3. Evaluate a regional landscape plan for its ecological connectivity, climate resilience, and coordination with land use regulations [Assessment]

A.12 Real Estate Development and Construction Economics (RED)

Real Estate Development and Construction Economics addresses the economic and financial dimensions of building projects. It covers market analysis, development feasibility, cost estimation, project

finance, housing policy, and the emerging role of technology (PropTech). Students learn to assess development opportunities, manage financial risk, and align project goals with market realities.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.12.1 Real Estate Market Analysis (Pg.. 265)	1	1
⭐ A.12.2 Development Process and Feasibility (Pg.. 265)	1	1
⭐ A.12.3 Construction Cost Estimation (Pg.. 266)	1	1
⭐ A.12.4 Project Finance and Investment (Pg.. 266)	1	1
A.12.5 Housing Policy and Affordable Development (Pg.. 267)	Elective	
A.12.6 Circular Economy and Adaptive Reuse Economics (Pg.. 267)	Elective	
A.12.7 Stakeholder and Participatory Development (Pg.. 268)	Elective	
A.12.8 PropTech and Digital Real Estate Innovation (Pg.. 268)	Elective	

Table A.12: List of KUs in the Real Estate Development and Construction Economics area.

A.12.1 RED/Real Estate Market Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the methods for analyzing real estate markets: supply and demand, absorption, vacancy, rent and price trends, market segmentation, and feasibility study integration.

Topics:

Core

- Real estate market indicators: absorption rate, vacancy rate, occupancy cost, rent per square foot, price per square foot, cap rate trends,
- Demand analysis: population and household projections, employment drivers, income trends, demographic cohorts (millennials, baby boomers), and the relationship between demand
- Supply analysis: existing stock, under-construction pipeline, proposed projects, development constraints (zoning, land availability, construction costs),
- Market segmentation by location (downtown, suburban, exurban), quality (Class A/B/C), and use (general office, medical office, life science, warehouse
- Integrating market analysis with feasibility: estimating achievable rent and absorption velocity from market data, adjusting for market cycle timing,
- Property appraisal (tasaciones): cost, income, and sales-comparison approaches to valuation; Peru's Reglamento Nacional de Tasaciones and the role of certified appraisers (peritos tasadores) in legal, financial, and insurance valuations

Learning Outcomes:

Core:

1. Describe the key indicators of real estate market conditions - absorption, vacancy, rent, cap rates - and explain how they inform development feasibility [Familiarity]
2. Perform a market analysis for a proposed development (residential, office, retail) in a specific location, forecasting demand, supply, [Usage]
3. Evaluate the market assumptions in a development pro forma, identifying overly optimistic rent growth or absorption projections, and proposing sensitivity scenarios [Assessment]

A.12.2 RED/Development Process and Feasibility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the stages of real estate development - site acquisition, due diligence, entitlements, financing, construction, leasing, and disposition - and the feasibility analysis that tests project viability at each stage.

Topics:

Core

- Development phases: site identification, option agreement, due diligence, entitlement (zoning, permits), design
- Due diligence for development sites: title review, environmental assessment (Phase I and II), geotechnical investigation, zoning analysis, utility availability,

- Entitlements and permitting: land use approvals (rezoning, variances, conditional use permits), building permits, impact fees (school, traffic, parks)
- Feasibility study components: market support, site suitability, regulatory pathway, construction feasibility, financial pro forma (with sensitivity analysis),
- Real estate pro forma basics: projected net operating income (NOI = gross potential rent minus vacancy allowance minus operating expenses), debt service coverage ratio (DSCR),

Learning Outcomes:
Core:

1. Describe the major stages of the real estate development process - predevelopment, construction, lease-up, disposition - and the due diligence [Familiarity]
2. Prepare a feasibility study for a proposed development, including market analysis, site due diligence summary, entitlement pathway, construction cost estimate, [Usage]
3. Evaluate a development pro forma for financial viability, identifying understated risk (vacancy, construction contingency) [Assessment]

A.12.3 RED/Construction Cost Estimation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the methods for estimating construction costs: order-of-magnitude, schematic, design development, and detailed estimates; cost databases, labor and material rates, and the use of cost estimation software.
Topics:
Core

- Construction estimate types: order-of-magnitude (square foot/meter cost), schematic (assembly-based cost), design development (unit cost with quantities)
- Cost data sources: RSMeans (US/Canada), BNI Building News, local cost indexes, subcontractor quotes, historical project data,
- Quantity takeoff for estimating: measuring quantities from drawings (excavation cubic yards, concrete cubic yards, rebar pounds, framing board feet, finishes square feet)
- Soft costs and contingencies: professional fees (architect, engineering, legal), permits, insurance, financing costs, development fee, marketing, tenant improvement allowances
- Cost indexes and location factors: Engineering News-Record (ENR) Construction Cost Index (CCI), Building Cost Index (BCI),

Learning Outcomes:
Core:

1. Describe the main types of construction cost estimates, the data sources used (RSMeans, local cost indexes), and the typical soft cost [Familiarity]
2. Prepare a schematic-level construction cost estimate for a building project, using assembly-based unit costs and including both hard costs (construction) and soft costs [Usage]
3. Evaluate a construction estimate for completeness and reasonableness, comparing to cost benchmarks for the building typology and location, [Assessment]

A.12.4 RED/Project Finance and Investment (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the financial analysis of development projects: capital stack, debt financing, equity returns, valuation metrics (cap rate, IRR, NPV), and the structuring of development funding.
Topics:
Core

- Capital stack: senior debt (construction loan, mini-perm loan), mezzanine debt, preferred equity, common equity
- Valuation metrics: direct capitalization (value = NOI / cap rate), discounted cash flow (DCF) analysis (NPV, IRR), equity multiple, and return on cost (ROC) vs.
- Construction financing: loan-to-cost ratio (LTC), loan-to-value (LTV), interest reserve, draw schedule,
- Equity return metrics: internal rate of return (IRR) for developers and passive equity partners, cash-on-cash return during lease-up, and the relationship between leveraged vs.

- Sensitivity analysis in development finance: changing rent, absorption, interest rate, and construction cost to determine break-even points and downside scenarios

Learning Outcomes:

Core:

1. Describe the components of a real estate capital stack and the valuation metrics (cap rate, IRR, NPV) used to assess development investment opportunities [Familiarity]
2. Build a development pro forma (DCF) for a multi-year development project, calculating project IRR, equity multiple, and debt service coverage, [Usage]
3. Evaluate a development financing proposal, assessing the riskiness of the capital stack, the appropriateness of the exit cap rate, and the adequacy of the interest reserve [Assessment]

A.12.5 RED/Housing Policy and Affordable Development

Covers the policy and financial mechanisms for affordable housing: inclusionary zoning, density bonus, tax credits, cross-subsidization, public-private partnerships, and community land trusts.

Topics:

Non Core

- The housing affordability gap: housing cost burden (>30% of income), income-to-rent ratios, production of affordable units vs.
- Policy tools for affordable housing: inclusionary zoning (mandatory vs. voluntary, in-lieu fees), density bonus (height, FAR) for providing affordable units, linkage fees,
- Affordable housing finance tools: Low-Income Housing Tax Credit (LIHTC) in US, Fondo Mi Vivienda (Peru), Minha Casa Minha Vida (Brazil)
- Public-private partnerships for affordable housing: land lease models, turnkey contracts, inclusionary housing,
- Housing vouchers and tenant-based assistance: impact on project feasibility, mixed-income project design, and the relationship between voucher market

Learning Outcomes:

NonCore:

1. Describe the policy and financial mechanisms for affordable housing - inclusionary zoning, density bonus, tax credits, cross-subsidization - [Familiarity]
2. Develop a financing strategy for an affordable housing development, incorporating inclusionary zoning density bonus, tax credits or subsidy, [Usage]
3. Evaluate an affordable housing development pro forma for financial feasibility and subsidy efficiency, assessing the trade-offs between unit mix, depth of affordability, [Assessment]

A.12.6 RED/Circular Economy and Adaptive Reuse Economics

Covers the economics of circular construction and adaptive reuse: financial viability of deconstruction vs. demolition, material salvage economics, and the business case for retrofitting over new build.

Topics:

Non Core

- Deconstruction vs. demolition cost-benefit: tax credits for salvaged materials, labor cost of selective deconstruction vs.
- Material salvage economics: market for reclaimed lumber, brick, structural steel, and architectural salvage
- Economic drivers for adaptive reuse: reduced construction time (faster occupancy), lower capital cost (retaining structure), historic tax credits (federal, state),
- Circular economy financing: green bonds for circular construction, material passports as collateral,
- Whole-life costing for circular buildings: higher upfront cost for reversible connections and durable materials offset by lower deconstruction cost, lower waste disposal,

Learning Outcomes:

NonCore:

1. Describe the economic drivers for deconstruction over demolition and for adaptive reuse over new build, including tax credits, salvage value, and embodied carbon accounting [Familiarity]

2. Perform a cost comparison between deconstruction and demolition for a building, incorporating salvage revenue, labor cost difference, and disposal cost savings, [Usage]
3. Evaluate the financial feasibility of a circular construction strategy (design for disassembly, material passport) using whole-life costing [Assessment]

A.12.7 RED/Stakeholder and Participatory Development

Covers methods for engaging stakeholders and communities in real estate development: community participation, benefit agreements, conflict resolution, and inclusive development models.
Topics:
Non Core

- Levels of stakeholder participation in development: inform, consult, involve, collaborate, empower (Arnstein's ladder)
- Community benefits agreements (CBA): negotiating community benefits (local hiring, affordable housing, public space) in exchange for development approval, legal enforceability
- Stakeholder mapping and analysis: identifying interest, influence, and impact on the development; designing engagement strategies for supportive, neutral,
- Inclusive development models: land trusts, cooperative housing, community land banks, and public-community partnerships that give residents a stake in development outcomes
- Participatory budgeting in development: allocating a portion of public infrastructure budget through community vote

Learning Outcomes:
NonCore:

1. Describe the levels of stakeholder participation in development and the mechanisms (CBA, participatory budgeting, land trust) for inclusive development [Familiarity]
2. Develop a community engagement plan for a real estate development project, identifying stakeholders, choosing participation methods, [Usage]
3. Evaluate a community benefits agreement or participatory process for representativeness, enforceability, and impact on equitable development outcomes [Assessment]

A.12.8 RED/PropTech and Digital Real Estate Innovation

Covers the technology innovations transforming real estate: digital platforms for leasing and sales, property management software, AI for valuation and market analysis, blockchain for title and transactions, and smart building technologies.
Topics:
Elective

- PropTech categories: marketing and leasing (listing platforms, CRM), asset and property management (tenant portals, maintenance platforms), data
- AI in real estate: automated valuation models (AVM), rent prediction models, tenant behavior analytics, and AI for site selection (site scoring, foot traffic analysis)
- Blockchain in real estate: tokenization of real estate assets (fractional ownership), smart contracts for lease
- Smart building data for real estate: IoT sensor data (occupancy, energy, indoor environmental quality) used for performance-based leasing, predictive maintenance,
- Commercial real estate tech (CREtech): online leasing platforms (VTS, Reonomy), virtual tours and 3D scanning, flex-space management software,

Learning Outcomes:
Elective:

1. Describe the main categories of PropTech (marketing, management, analytics, investment, construction) and how they affect real estate development and operations [Familiarity]
2. Propose a PropTech solution to a real estate development or management problem (e.g., lease-up velocity, tenant retention, valuation accuracy), specifying the data sources [Usage]
3. Evaluate a PropTech startup or platform for its value to developers or investors, assessing its data accuracy, integration capabilities, regulatory compliance, [Assessment]

A.13 Research Methods and Emerging Technologies (RES)

Research Methods and Emerging Technologies equips students with the methodologies to conduct systematic inquiry in architecture. It covers research design, quantitative and qualitative methods, evidence-based design, neuroscience approaches, AI in research, speculative futures, IoT and sensing, and post-occupancy evaluation. Students learn to frame research questions, collect and analyze data, and apply findings to design practice.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.13.1 Research Design and Methodologies (Pg.. 269)	1	1
⭐ A.13.2 Quantitative Methods in Architectural Research (Pg.. 269)	1	1
⭐ A.13.3 Qualitative and Ethnographic Methods (Pg.. 270)	1	1
⭐ A.13.4 Evidence-Based Design (Pg.. 270)	1	1
A.13.5 Neuroscience and Cognitive Approaches (Pg.. 271)	Elective	
⭐ A.13.6 AI and Machine Learning in Architectural Research (Pg.. 271)	1	1
A.13.7 Speculative and Future-Oriented Research (Pg.. 272)	Elective	
A.13.8 IoT, Sensing, and Smart Building Research (Pg.. 272)	Elective	
⭐ A.13.9 Post-Occupancy Evaluation and Building Science (Pg.. 273)	1	1
⭐ A.13.10 Theoretical Framework and Literature Review (Pg.. 273)	1	1
⭐ A.13.11 Research Hypotheses and Variables (Pg.. 274)	1	1

Table A.13: List of KUs in the Research Methods and Emerging Technologies area.

A.13.1 RES/Research Design and Methodologies (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the design of architectural research: formulating research questions, selecting methodological approaches, constructing research protocols, and addressing validity and reliability in architectural inquiry.

Topics:

Core

- Formulating research questions in architecture: descriptive, relational, causal; turning design problems into researchable questions
- Choosing a research methodology: quantitative (hypothesis testing, statistical), qualitative (interpretive, case study), mixed methods,
- Validity and reliability in architectural research: internal validity, external validity (generalizability), construct validity,
- Research ethics in architectural research: informed consent, privacy (anonymization of building users), institutional review board (IRB) protocols,
- Mixed methods research: sequential (qualitative then quantitative) and concurrent designs; integrating qualitative findings (user interviews) with quantitative data (occupancy

Learning Outcomes:

Core:

1. Describe the main research methodologies in architecture - quantitative, qualitative, mixed methods, practice-based - and explain their appropriate applications [Familiarity]
2. Develop a research design for an architectural inquiry, including research question, literature review, methodology selection, data collection protocol, and analysis plan [Usage]
3. Evaluate the research design of a published architectural study for validity, reliability, and ethical soundness, identifying methodological strengths and weaknesses [Assessment]

A.13.2 RES/Quantitative Methods in Architectural Research (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers quantitative research methods in architecture: surveys, experiments, quasi-experiments, statistical analysis (descriptive and inferential), and the use of instrumentation for data collection.

Topics:
Core

- Survey design for architectural research: sampling methods (probability, convenience), questionnaire design (Likert scales, semantic differential), response rate optimization,
- Experimental designs: true experiments (random assignment, control group), quasi-experiments (non-randomized, pre-post, time series),
- Descriptive statistics: measures of central tendency (mean, median, mode), dispersion (standard deviation, range, interquartile range),
- Inferential statistics: hypothesis testing (t-test, ANOVA, chi-square), correlation and regression (linear, multiple), and interpretation of p-values
- Instrumentation for quantitative data collection: environmental sensors (temperature, light, CO_2), occupancy counters, objective performance measures (task completion time

Learning Outcomes:
Core:

1. Describe the main quantitative methods in architectural research - surveys, experiments, quasi-experiments - [Familiarity]
2. Design a survey or experiment to test a hypothesis about the effect of a design variable (lighting, color, layout) on user satisfaction, task performance, or behavior [Usage]
3. Evaluate a quantitative architectural study for sampling validity, statistical analysis appropriateness, and correct interpretation of p-values and effect sizes [Assessment]

A.13.3 RES/Qualitative and Ethnographic Methods (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers qualitative research methods for architecture: interviews, focus groups, participant observation, ethnographic fieldwork, content analysis, and grounded theory for understanding user experience and design processes.
Topics:
Core

- Interviews and focus groups: structured vs. semi-structured vs. unstructured interviews, focus group dynamics, questioning strategies (probing, laddering), and recording
- Ethnography and observation in architecture: participant observation (researcher as user), non-participant observation (fly-on-the-wall), time-sampling behavior mapping,
- Content and thematic analysis: coding qualitative data (open coding, axial coding, selective coding), identifying themes
- Grounded theory approach in architectural research: generating theory from data rather than hypothesis testing; constant comparative method
- Case study methodology in architecture: single vs. multiple case design, case selection (typical, extreme, revelatory), data triangulation (documents, interviews, observations)

Learning Outcomes:
Core:

1. Describe the main qualitative methods in architectural research - interviews, focus groups, ethnography, grounded theory - [Familiarity]
2. Conduct a qualitative study (interview, observation, or focus group) to investigate how users experience a built space, and analyze the data using thematic coding [Usage]
3. Evaluate the rigor of a qualitative architectural study based on credibility, transferability, dependability, and confirmability criteria (Lincoln & Guba) [Assessment]

A.13.4 RES/Evidence-Based Design (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the application of research evidence to design decision-making: systematic reviews, practice guidelines, knowledge translation, and the integration of best available evidence with design expertise and client values.
Topics:
Core

- Evidence-based design (EBD) framework: formulating a clinical or design question, searching for best evidence (hierarchy of evidence), critically appraising evidence
- Hierarchy of evidence in architecture: systematic reviews and meta-analyses, randomized controlled trials (RCTs) in healthcare design, quasi-experimental studies, case studies
- Systematic reviews and meta-analysis in EBD: steps (protocol, search strategy, inclusion criteria, data extraction, synthesis), using PRISMA guidelines,
- Practice guidelines from evidence: AIA Design Guidelines for Healthcare Facilities, WELL Building Standard evidence documentation,
- Post-occupancy evaluation (POE) as evidence feedback: comparing design intent to measured outcomes (satisfaction, productivity, safety), feeding results into future projects,

Learning Outcomes:
Core:

1. Describe the evidence-based design process: question formulation, evidence search, critical appraisal, integration, and outcome evaluation - [Familiarity]
2. Apply an evidence-based design approach to a specific design problem (e.g., patient room, classroom, open office), citing peer-reviewed studies to support key design decisions [Usage]
3. Evaluate a design claim or guideline for its evidence base, assessing the quality of cited studies (design, sample size, statistical significance) [Assessment]

A.13.5 RES/Neuroscience and Cognitive Approaches

Covers the emerging field of neuroscience and cognitive science applied to architecture: measuring brain responses to built environments, cognitive load, emotional response, and the neural basis of spatial experience.
Topics:
Non Core

- Neuroscience methods for architecture: EEG (electroencephalogram) for real-time cognitive load and emotional arousal
- Spatial cognition and wayfinding: cognitive maps, landmark-based navigation, grid cell and place cell activity in the hippocampus, and the neural mechanisms of orientation
- Neuroscience of stress and restoration: the effect of nature views, windows, daylight, and ceiling height on cortisol reduction and prefrontal cortex activity
- Neuroaesthetics in architecture: brain response to curvature vs. angularity, complexity vs. simplicity, symmetry vs.
- Cognitive load and environmental design: the impact of clutter, noise, lighting flicker, and distraction on cognitive resource allocation (attentional capacity, memory

Learning Outcomes:
NonCore:

1. Describe the neuroscience methods (EEG, fMRI, eye-tracking) used to study the brain's response to built environments [Familiarity]
2. Design a research protocol using neuroscience methods to test a hypothesis about the effect of a design variable (ceiling height, curvature [Usage]
3. Evaluate the validity and generalizability of a neuroscience study in architecture, assessing sample size, control of confounds, [Assessment]

A.13.6 RES/AI and Machine Learning in Architectural Research (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the application of artificial intelligence and machine learning to architectural research: generative models for design exploration, computer vision for urban analysis, natural language processing for building codes, and reinforcement learning for spatial optimization.
Topics:
Core

- Machine learning on architectural data: image classification of architectural styles (CNN), clustering of floor plans (PCA, t-SNE)

- Generative design using ML: GANs (generative adversarial networks) for floor plan and facade generation
- Computer vision for urban and building research: semantic segmentation of street view images for urban form analysis (walkability, skyline, green view index)
- Natural language processing for architectural research: automated extraction of design requirements from client briefs, classification of building code clauses
- Reinforcement learning for spatial layout: training RL agents to generate floor plans that satisfy constraints (area, adjacency, circulation)

Learning Outcomes:
Core:

1. Describe the main AI and ML methods - computer vision, generative modeling, NLP, reinforcement learning - applied to architectural research problems [Familiarity]
2. Train or fine-tune a machine learning model (CNN for classification, GAN for image generation, or RL for layout) on a modest architectural dataset [Usage]
3. Evaluate the performance and limitations of an AI model in architectural research, assessing data quality, overfitting, generalization to unseen conditions, [Assessment]

A.13.7 RES/Speculative and Future-Oriented Research

Covers speculative and critical design methods used to explore possible futures, challenge assumptions, and provoke debate through design research artifacts.
Topics:
Non Core

- Speculative design methodology: creating artifacts (objects, narratives, scenarios) that depict alternative presents or futures; distinguishing speculative from commercial design
- Design fiction as research: writing future press releases, creating fictional product catalogs, building prototype artifacts from imagined futures
- Critical design (Dunne & Raby): using design to critique social, technical, and cultural norms; examples in architecture (critical interiors, provocations on housing
- Futures research methods: scenario planning (alternative futures), backcasting from desired future to present actions, horizon scanning for emerging signals,
- Ethics of speculative research: avoiding fear-mongering or dystopian pessimism without agency; engaging stakeholders in co-speculation

Learning Outcomes:
NonCore:

1. Describe the methods of speculative and critical design, design fiction, and futures studies, and explain their role in architectural research beyond problem-solving [Familiarity]
2. Produce a speculative design artifact (scenario, prototype, narrative) that investigates a future condition for architecture - climate change, AI, demographic shift - [Usage]
3. Evaluate a speculative architecture project for its critical rigor, plausibility of its future scenario, [Assessment]

A.13.8 RES/IoT, Sensing, and Smart Building Research

Covers the use of Internet of Things (IoT) sensors and data analytics in architectural research: occupancy monitoring, environmental sensing, building performance tracking, and the ethical challenges of data collection in occupied spaces.
Topics:
Non Core

- IoT sensor types for buildings: occupancy (PIR, CO_2, camera, seat counters), environmental (temperature, humidity, light, noise, air quality), energy (plug-load monitors
- Data pipeline for building IoT: sensor placement (density, calibration), data collection (edge vs. cloud), time-series databases (InfluxDB, Timescale),
- Occupancy modeling from sensor data: using CO_2 and motion to estimate real-time occupancy patterns, dwell time, and space utilization ratios

- Performance dashboards for buildings: visualizing real-time energy use, IEQ, and occupancy; using dashboards for occupant feedback (feedback loops) to reduce energy,
- Ethical issues in building IoT: informed consent for data collection in public and semi-public spaces, anonymization of occupant data, data ownership (building owner vs.

Learning Outcomes:
NonCore:

1. Describe the types of IoT sensors used in building research and the data they collect (occupancy, environment, energy) for post-occupancy evaluation and performance monitoring [Familiarity]
2. Design an IoT sensing plan for a building research question (e.g., space utilization, thermal comfort), specifying sensor type, placement, data collection duration, [Usage]
3. Evaluate the ethical and technical adequacy of an IoT sensing deployment in a building, assessing privacy protections, data quality, [Assessment]

A.13.9 RES/Post-Occupancy Evaluation and Building Science (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the systematic evaluation of building performance after occupancy: methods for assessing technical performance (energy, thermal comfort, IAQ) and user satisfaction (comfort, well-being, productivity), and feeding findings back into design practice.
Topics:
Core

- Post-occupancy evaluation (POE) methods: walkthroughs, surveys (POE questionnaire, BUS Methodology), focus groups, building diagnostics (energy metering, blower door),
- User satisfaction metrics: thermal satisfaction, perceived air quality, acoustic satisfaction, lighting quality, visual comfort, privacy, control over environment,
- Building performance gap: difference between predicted (energy model, design intent) and measured (energy use, comfort, IAQ) performance
- Building science measurement techniques: thermal imaging for envelope performance, data loggers for T/RH, CO_2 monitors for IAQ, light meters for illuminance,
- Closing the feedback loop: integrating POE findings into design guidelines, updating building energy models with measured data,

Learning Outcomes:
Core:

1. Describe the methods of post-occupancy evaluation - surveys, walkthroughs, building diagnostics - and the concept of the building performance gap [Familiarity]
2. Conduct a post-occupancy evaluation of a building (survey, walkthrough, limited data logging), analyzing user satisfaction data alongside measured performance data to identify [Usage]
3. Evaluate a POE report for methodological rigor, representativeness of respondents, alignment of questions with design intent, and actionable recommendations for future design [Assessment]

A.13.10 RES/Theoretical Framework and Literature Review (Core Tier1: 1 hr, Core Tier2: 1 hr)

Systematic process of identifying, analyzing, and synthesizing existing scientific and technical literature to build the theoretical and conceptual framework underpinning a research project, including bibliographic reference management and the identification of knowledge gaps.
Topics:
Core

- Systematic search of scientific and technical literature: specialized databases (Scopus, Web of Science, ASCE Library), keywords, and Boolean operators
- Critical reading and synthesis of scientific articles, technical standards, and prior research reports
- Building the conceptual and theoretical framework: defining key concepts, relationships between variables, and reference theoretical models
- Identifying knowledge gaps (research gap) and justifying the originality of the proposed contribution

- Bibliographic reference management and citation styles (APA, IEEE) using tools such as Zotero or Mendeley

Learning Outcomes:
Core:

1. Explain the structure and purpose of a theoretical framework within a civil engineering research project [Familiarity]
2. Conduct a systematic search of scientific and technical literature on a chosen research topic using specialized databases [Usage]
3. Synthesize the state of the art of a research topic into a coherent theoretical framework that identifies a knowledge gap [Assessment]

A.13.11 RES/Research Hypotheses and Variables (Core Tier1: 1 hr, Core Tier2: 1 hr)

Formulation of research hypotheses and the identification, classification, and operationalization of the variables involved in an engineering study, establishing the link between the theoretical framework and the experimental or data-collection design.

Topics:
Core

- Types of hypotheses: null, alternative, directional, and non-directional, and their relationship to research questions
- Classification of variables: independent, dependent, control, and confounding
- Operationalizing variables: defining measurable indicators and measurement scales (nominal, ordinal, interval, ratio)
- Relationship between hypotheses, variables, and statistical significance tests: significance level, Type I and Type II error
- Graphical representation of the relationship between variables through conceptual or operational models

Learning Outcomes:
Core:

1. Distinguish between null and alternative hypotheses, and between independent, dependent, and control variables, in a civil engineering research problem [Familiarity]
2. Formulate a testable research hypothesis and operationalize its variables for a specific problem in the chosen specialization area [Usage]
3. Evaluate the consistency between the theoretical framework, the stated hypothesis, and the proposed data-collection design [Assessment]

A.14 Architectural Regulations and Standards (NRM)

Architectural Regulations and Standards covers the codified rules – international, national, and local – that govern what architects may design, how they may design it, and how the built result is licensed, registered, and valued. It spans generic building/accessibility/energy/zoning codes as well as the specific legal and regulatory framework of a given country, including building-permit law, specialized-facility norms, property regularization, national BIM mandates, and heritage protection law.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.14.1 Building Codes, Accessibility, and Zoning (Pg.. 275)	1	1
⭐ A.14.2 Peruvian Regulatory Framework for Architectural Practice (Pg.. 275)	1	1

Table A.14: List of KUs in the Architectural Regulations and Standards area.

A.14.1 NRM/Building Codes, Accessibility, and Zoning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the generic, internationally-recognized regulatory environment of architectural practice: building codes (life safety, accessibility, structural, energy), zoning and land use regulations, and legal frameworks for permits, variances, and appeals.

Topics:

Core

- Building codes and standards: IBC (International Building Code), IRC (International Residential Code), IFC (International Fire Code)
- Means-of-egress and fire-evacuation route design: maximum travel distance to an exit, number and width of exits required by occupant load, exit discharge and assembly points, and diagramming evacuation routes on a life-safety plan
- Accessibility codes: ADA Standards for Accessible Design, ICC A117.1, and local accessible building codes
- Energy codes: IECC (International Energy Conservation Code), ASHRAE 90.1; prescriptive vs. performance paths
- Zoning and land use regulations: zoning districts (residential, commercial, industrial, mixed-use), floor area ratio (FAR), lot coverage, setbacks, height limits
- Permitting process: building permit, variance, special exception; code interpretation appeals; the architect's role in preparing permit sets, responding to plan review comments

Learning Outcomes:

Core:

1. Describe the key provisions of building codes that affect architectural design - occupancy classification, means of egress, fire-resistance, accessibility, and energy performance [Familiarity]
2. Apply IBC occupancy and construction type tables to determine allowable building area and height for a given use and sprinkler status, [Usage]
3. Evaluate a building design's code compliance for accessibility (ADA) and life safety (IBC), identifying violations and recommending code-conforming modifications [Assessment]

A.14.2 NRM/Peruvian Regulatory Framework for Architectural Practice (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the specific legal and regulatory framework governing architectural practice in Peru: building-permit law, the national building code, specialized-facility norms, property regularization, and national BIM policy.

Topics:

Core

- Peru's national regulatory framework: Ley 29090 (Ley de Regulación de Habilitaciones Urbanas y de Edificaciones) governing building-permit modalities (A-D) and urban subdivision licensing; the Reglamento Nacional de Edificaciones (RNE) as the overarching technical building code; and the Colegio de Arquitectos del Perú's (CAP) role in professional practice
- Habilitación urbana (urban land subdivision) as the legal prerequisite to any building permit: the RNE's Título II norms (TH.010-TH.090) governing lot and road layout, minimum infrastructure (water, sewer, electricity, paving), and the mandatory land dedications (aportes reglamentarios) for parks, education, recreation, and public safety
- Specialized building-type regulations in Peru: MINSA's Normas Técnicas de Salud for hospital and health-facility design; RNE Norma A.070 (Comercio) and municipal requirements for shopping centers and large commercial complexes
- Saneamiento físico legal de edificaciones: legal and registry regularization of buildings and land (independización, acumulación, declaratoria de fábrica, regularización de edificaciones sin licencia) for recording at SUNARP
- National BIM adoption mandates: Peru's Plan BIM Perú roadmap requiring Building Information Modeling on public infrastructure projects, and its implications for permit submission and interdisciplinary coordination. See also: BIM Standards, Policy, and Contracts

Learning Outcomes:
Core:

1. Describe the Peruvian legal framework governing building permits, licensing modalities, and professional registration (Ley 29090, RNE, CAP) [Familiarity]
2. Apply the specialized facility norms (MINSA health-facility standards, RNE commercial-building provisions) relevant to a given building type [Usage]
3. Evaluate a project's compliance with Peru's property-regularization requirements and national BIM mandate, identifying gaps in legal or digital-model deliverables [Assessment]

A.15 Building Information Modeling (BIM)

Building Information Modeling covers the object-based digital representation of a building and the data-centric workflows built around it: authoring and parametric modeling, multidisciplinary coordination, construction and facilities-management integration, and the standards, regulations, and emerging AI-driven automation that govern BIM practice across a project's full lifecycle - from early design through construction, operation, heritage documentation, and infrastructure.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ A.15.1 BIM Fundamentals and Authoring (Pg.. 277)	1	1
⭐ A.15.2 Parametric Modeling and Visual Scripting for BIM (Pg.. 277)	1	1
⭐ A.15.3 Multidisciplinary Model Coordination (Pg.. 278)	1	1
⭐ A.15.4 4D BIM and Construction Scheduling (Pg.. 278)	1	1
⭐ A.15.5 5D BIM and Cost Estimation (Pg.. 278)	1	1
⭐ A.15.6 BIM for Structural and MEP Coordination (Pg.. 279)	1	1
⭐ A.15.7 BIM for Sustainability Analysis (Pg.. 279)	1	1
⭐ A.15.8 BIM for Facilities Management (Pg.. 279)	1	1
⭐ A.15.9 BIM Execution Planning and Standards (Pg.. 280)	1	1
⭐ A.15.10 Collaborative BIM Workflows (Pg.. 280)	1	1
⭐ A.15.11 Heritage BIM (HBIM) (Pg.. 280)	1	1
⭐ A.15.12 BIM for Infrastructure and Urban Modeling (Pg.. 281)	1	1
⭐ A.15.13 AI-Assisted BIM Automation (Pg.. 281)	1	1
⭐ A.15.14 BIM Standards, Policy, and Contracts (Pg.. 282)	1	1
⭐ A.15.15 BIM-Based Construction Documentation (Pg.. 282)	1	1
⭐ A.15.16 BIM Model Organization and Worksharing (Pg.. 283)	1	1
⭐ A.15.17 Generative Design and Optioneering (Pg.. 283)	1	1
⭐ A.15.18 Model-Based Issue and RFI Management (Pg.. 283)	1	1
⭐ A.15.19 BIM Across Project Delivery Methods (Pg.. 284)	1	1
⭐ A.15.20 Lean Construction and 4D BIM Integration (Pg.. 284)	1	1
⭐ A.15.21 Fabrication-Level BIM Detailing (Pg.. 285)	1	1
⭐ A.15.22 BIM Model Quality Control and Auditing (Pg.. 285)	1	1
⭐ A.15.23 BIM for Circular Economy and Material Reuse (Pg.. 285)	1	1
⭐ A.15.24 BIM-Supported Green Building Certification (Pg.. 286)	1	1
⭐ A.15.25 Operational Digital Twins from BIM (Pg.. 286)	1	1
⭐ A.15.26 Asset Classification and Data Standards for FM (Pg.. 287)	1	1
⭐ A.15.27 Reality Capture for BIM: Point Clouds and Photogrammetry (Pg.. 287)	1	1
⭐ A.15.28 Integrated BIM Project Delivery (Capstone) (Pg.. 287)	1	1
A.15.29 Emerging Trends in BIM Practice (Pg.. 288)	Elective	
⭐ A.15.30 BIM Software Practicum (Pg.. 288)	1	1

Table A.15: List of KUs in the Building Information Modeling area.

A.15.1 BIM/BIM Fundamentals and Authoring (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the foundational concepts of Building Information Modeling: object-based parametric modeling, authoring tools, level of development (LOD), and open data-exchange standards.

Topics:

Core

- Core BIM concepts: object-oriented modeling (walls, doors, windows with embedded data), parametric relationships (hosting, constraints), and the difference between BIM and conventional 2D/3D modeling
- BIM authoring tools: Revit (project-based, family editor), ArchiCAD (virtual building model), Vectorworks, and their respective modeling philosophies and interoperability
- Level of development (LOD) specification: LOD 100 (conceptual), 200 (schematic), 300 (detailed), 350 (construction-ready), 400 (fabrication), 500 (as-built)
- Data exchange standards: Industry Foundation Classes (IFC) as openBIM exchange format, IFC schema (IfcWall, IfcDoor, IfcWindow, IfcSpace), and vendor-neutral model interoperability

Learning Outcomes:

Core:

1. Describe the core concepts of BIM: object-based modeling, parametric relationships, LOD, and data exchange via IFC, and explain how BIM differs from traditional 2D CAD [Familiarity]
2. Develop a BIM model of a small building at LOD 200-300, producing plans, sections, elevations, and a simple schedule directly from the model, and export the model to IFC format [Usage]
3. Evaluate a BIM model for appropriate LOD, correct parametric relationships, and clean IFC export, identifying modeling errors that would impede downstream coordination or data exchange [Assessment]

A.15.2 BIM/Parametric Modeling and Visual Scripting for BIM (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the authoring of parametric BIM content and the use of visual programming to extend and automate BIM authoring tools beyond their standard interface.

Topics:

Core

- Parametric family and component authoring: creating custom BIM families with parametric constraints, formulas, and type/instance parameters (Revit families, ArchiCAD GDL objects)
- Adaptive and generative components: adaptive component modeling for non-standard geometry, nested and shared parameters, and parametric array/pattern-based component placement
- Visual programming for BIM automation: Dynamo and Grasshopper-to-Revit workflows for geometry generation, data extraction, and model auditing

Non Core

- Integrating computational design with BIM: round-tripping geometry between parametric-design environments and BIM authoring tools, and managing model complexity and file size

Learning Outcomes:

Core:

1. Describe the difference between a standard BIM family or component and a parametric or adaptive one, and identify when visual scripting is an appropriate tool for a BIM modeling task [Familiarity]
2. Author a parametric family or component with meaningful parametric constraints, and use a visual-scripting tool to automate a repetitive BIM modeling or data-extraction task [Usage]
3. Evaluate a parametric BIM family or visual script for robustness, reusability, and appropriateness to the design problem it addresses [Assessment]

A.15.3 BIM/Multidisciplinary Model Coordination (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the coordination of federated, multidisciplinary BIM models to identify and resolve conflicts before construction, and the shared data environment that governs model and document exchange.

Topics:

Core

- BIM coordination and clash detection: federated model assembly, hard and soft clash detection in Navisworks or Solibri, clash resolution workflows, and the reduction of RFIs
- IFC and open BIM standards: the IFC schema for vendor-neutral model exchange, BCF (BIM Collaboration Format) for issue tracking, and openBIM coordination workflows across authoring platforms
- Common Data Environment (CDE): shared, work-in-progress, published, and archive states for model and document management; naming conventions and version control in a multi-party project

Learning Outcomes:

Core:

1. Describe the role of model coordination in a multidisciplinary project, including federated models, clash detection, and the Common Data Environment [Familiarity]
2. Apply BIM coordination tools to detect and resolve clashes in a federated building model, documenting issues through a Common Data Environment workflow [Usage]
3. Evaluate a model-coordination protocol for a construction project, assessing federation strategy, clash-detection coverage, and CDE governance [Assessment]

A.15.4 BIM/4D BIM and Construction Scheduling (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the integration of BIM elements with construction schedules to simulate, communicate, and review the sequencing of construction work over time.

Topics:

Core

- 4D BIM and construction scheduling: linking BIM elements to Gantt chart activities in Synchro or Navisworks TimeLiner
- Construction sequencing simulation: visualizing phased construction, logistics, and site congestion through 4D animation for stakeholder communication and constructability review

Learning Outcomes:

Core:

1. Describe the concept of 4D BIM and explain how linking model elements to schedule activities supports construction planning and communication [Familiarity]
2. Link a BIM model's elements to a construction schedule to produce a 4D sequencing simulation for a building project [Usage]
3. Evaluate a 4D construction sequencing simulation for its accuracy, clarity, and usefulness in identifying logistics or site-congestion problems [Assessment]

A.15.5 BIM/5D BIM and Cost Estimation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the extraction of quantities from a BIM model and their use for real-time, model-linked cost estimation throughout the design and construction process.

Topics:

Core

- Model-based quantity takeoff and cost estimation: automated schedule extraction from BIM elements, level of development (LOD) requirements for cost estimation
- 5D cost modeling: linking BIM quantities to unit costs for real-time budget tracking across design iterations, and change-order cost impact analysis

Learning Outcomes:

Core:

1. Describe how BIM-based quantity takeoff supports cost estimation, and explain the relationship between model LOD and estimate accuracy [Familiarity]
2. Extract quantities from a BIM model and link them to unit costs to produce a model-based cost estimate for a design option [Usage]
3. Evaluate a 5D cost model for completeness and accuracy, identifying quantities that are missing, duplicated, or misclassified [Assessment]

A.15.6 BIM/BIM for Structural and MEP Coordination (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of BIM to coordinate the architectural model with structural analysis software and MEP (mechanical, electrical, plumbing) systems routing.

Topics:

Core

- BIM-based structural workflows: structural analysis model from architectural BIM (Revit, Tekla), data exchange via IFC or CIS/2
- MEP systems coordination in BIM: routing and clash-avoidance for HVAC ducts, plumbing, and electrical conduit within a federated model; spatial coordination with structural and architectural elements

Learning Outcomes:

Core:

1. Describe the BIM-based workflow for exchanging a model between architectural, structural, and MEP software, and explain the role of IFC/CIS2 in that exchange [Familiarity]
2. Coordinate a federated model's structural and MEP elements, identifying and resolving spatial conflicts between systems [Usage]
3. Evaluate a structural/MEP-coordinated BIM model for spatial conflicts, data-exchange integrity, and coordination completeness [Assessment]

A.15.7 BIM/BIM for Sustainability Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of BIM models as the data source for energy, daylight, and material-sustainability analysis throughout the design process.

Topics:

Core

- BIM-integrated energy analysis: gbXML export from BIM authoring tools to energy-simulation engines, and iterative design-stage energy performance feedback
- BIM-integrated daylight and solar analysis: linking BIM massing and material data to daylight simulation (Insight, IES-VE) and solar-access studies

Non Core

- Embedding sustainability data in BIM objects: embodied-carbon data (EPDs) and material-passport information attached to BIM elements for lifecycle assessment

Learning Outcomes:

Core:

1. Describe how BIM models can be exported or linked to energy, daylight, and sustainability-analysis tools, and explain the data requirements for each [Familiarity]
2. Export a BIM model's geometry and material data to run an energy or daylight analysis, and use the results to inform a design iteration [Usage]
3. Evaluate a BIM-based sustainability analysis for data accuracy and the appropriateness of its design recommendations [Assessment]

A.15.8 BIM/BIM for Facilities Management (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the handover of a construction BIM model into a facilities-management and operations environment, and its evolution into an operational digital twin.

Topics:

Core

- BIM handover and facilities management: COBie data for asset management, as-built BIM models, digital twin seeding from construction BIM

Learning Outcomes:
Core:

1. Describe the BIM-to-FM handover process, including COBie data requirements and the role of as-built models in facilities management [Familiarity]
2. Prepare a COBie data set and as-built BIM model for handover to a facilities-management team [Usage]
3. Evaluate a BIM-to-FM handover package for completeness and usability, identifying missing asset data or model discrepancies [Assessment]

A.15.9 BIM/BIM Execution Planning and Standards (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the planning documents and international standards that define how BIM is used, exchanged, and governed across a project team.
Topics:
Core

- BIM Execution Plan (BEP): project goals for BIM use (clash detection, 4D/5D, facility management), LOD matrix by discipline, model sharing protocols
- ISO 19650 framework: information management using BIM across the delivery and operational phases of assets, information requirements (EIR, OIR, AIR), and the information-delivery cycle

Learning Outcomes:
Core:

1. Describe the purpose of a BIM Execution Plan and the ISO 19650 information-management framework, and explain how they structure a project's BIM deliverables [Familiarity]
2. Draft a BIM Execution Plan for a project, specifying BIM goals, LOD matrix, and information-delivery milestones aligned with ISO 19650 [Usage]
3. Evaluate a BIM Execution Plan for a design project, assessing its LOD specifications, exchange protocols, and BIM use cases for adequacy and clarity [Assessment]

A.15.10 BIM/Collaborative BIM Workflows (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the collaborative, cloud-based workflows that let multiple disciplines work on a shared BIM model in real time.
Topics:
Core

- BIM collaboration: federated models, clash detection and resolution, model-based quantity take-off for estimating
- Cloud-based BIM collaboration platforms: real-time multi-user editing (BIM 360/ACC, BIMcloud, Trimble Connect), permissions, and worksharing

Learning Outcomes:
Core:

1. Describe how cloud-based BIM collaboration platforms support real-time, multi-user, multidisciplinary model development [Familiarity]
2. Develop a BIM collaboration protocol for a project, specifying model sharing standards, clash detection frequency, and meeting rhythms [Usage]
3. Evaluate a project's BIM collaboration setup for its effectiveness in supporting multidisciplinary, real-time teamwork [Assessment]

A.15.11 BIM/Heritage BIM (HBIM) (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the adaptation of Building Information Modeling for heritage documentation and management: Heritage BIM (HBIM), parametric modeling of historic elements, and digital twins for conservation planning and monitoring.

Topics:
Core
- Heritage BIM (HBIM): object-oriented modeling of historic buildings using non-parametric (discrete) and parametric libraries
- Scan-to-BIM workflow: processing point clouds from laser scanning to create 3D models with semantic decomposition (walls, vaults, windows)
- Semantic enrichment for heritage: adding conservation data (material type, decay grade, past interventions, monitoring history) to BIM objects
- Digital twins for heritage: integrating real-time monitoring sensors (cracks, displacement, humidity, temperature) with HBIM

Non Core
- HBIM standards and guidelines: ICOMOS HBIM Guidelines, CIDOC CRM for cultural heritage data, and the integration of HBIM with conservation management plan data fields

Learning Outcomes:
Core:
1. Describe the concept of Heritage BIM (HBIM) and explain how it differs from conventional BIM in terms of geometry representation and semantic data [Familiarity]
2. Create an HBIM model of a historic building element (vault, window, wall) from laser scan data, enriching it with semantic data (material, decay condition, past interventions) [Usage]
3. Evaluate a proposed HBIM workplan for a heritage project, assessing the level of detail required for documentation and the compatibility of data schema with monitoring needs [Assessment]

A.15.12 BIM/BIM for Infrastructure and Urban Modeling (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the extension of BIM methods beyond vertical buildings to horizontal/civil infrastructure and city-scale urban information models.

Topics:
Core
- BIM for horizontal/civil infrastructure: roads, bridges, and utility networks modeled with alignment-based and corridor-modeling tools (Civil 3D, InfraWorks), distinct from vertical-building BIM authoring
- City Information Modeling (CIM) and urban digital twins: integrating building-scale BIM with city-scale GIS data (CityGML, 3D Tiles) for planning and infrastructure coordination

Learning Outcomes:
Core:
1. Describe how BIM methods extend to horizontal infrastructure and city-scale modeling, and identify the tools and data standards specific to each scale [Familiarity]
2. Model a piece of infrastructure (road segment, utility corridor) using alignment-based BIM tools, and integrate it with an urban-scale GIS dataset [Usage]
3. Evaluate an infrastructure or city-information model for data interoperability between building-scale BIM and city-scale GIS systems [Assessment]

A.15.13 BIM/AI-Assisted BIM Automation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of artificial intelligence and scripted automation to generate, check, and optimize BIM content and workflows.

Topics:
Core
- AI-assisted BIM automation: generative design for structural and MEP routing, automated code compliance checking, NLP-based specification extraction
- BIM automation and scripting: automating repetitive tasks (door and window schedules, room data sheets), generative layout for bathrooms and parking

Non Core
- AI-assisted code compliance checking: NLP for parsing building-code provisions, automated rule checking of BIM models against applicable codes

Learning Outcomes:
Core:

1. Describe how AI and scripted automation can generate, check, and optimize BIM content, and identify tasks that are good candidates for automation [Familiarity]
2. Automate a repetitive BIM task (schedule generation, code-compliance check, or layout generation) using a scripted or AI-assisted tool [Usage]
3. Evaluate an AI-assisted or scripted BIM automation tool for its accuracy, reliability, and actual time savings over manual methods [Assessment]

A.15.14 BIM/BIM Standards, Policy, and Contracts (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the policy frameworks that mandate or incentivize BIM adoption, and the contractual mechanisms that allocate risk, authorship, and liability for shared model data.
Topics:
Core

- National and regional BIM adoption mandates: policy frameworks requiring BIM on public infrastructure projects (e.g. Peru's Plan BIM Perú, UK BIM Mandate, EU BIM Task Group), and their implications for permit submission and interdisciplinary coordination
- BIM in contracts and risk allocation: BIM Execution Plans as contract exhibits, model-authorship and liability clauses, and intellectual-property considerations for shared model data

Learning Outcomes:
Core:

1. Describe the major national and international BIM policy frameworks, and explain how BIM Execution Plans and authorship clauses are used to allocate contractual risk [Familiarity]
2. Identify the BIM mandate or policy applicable to a given project's jurisdiction, and draft a contract clause addressing model authorship and liability [Usage]
3. Evaluate a project's compliance with applicable BIM mandates and the adequacy of its contractual provisions for model authorship and liability [Assessment]

A.15.15 BIM/BIM-Based Construction Documentation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the production of a complete construction documentation set directly from a BIM model: sheet and view organization, schedules, and model-derived export formats.
Topics:
Core

- Sheet and view setup from the model: plan, section, elevation, and detail views generated directly from the BIM model, view templates, and view-specific graphic overrides
- Automated schedule generation: door, window, room finish, and area schedules extracted live from model data, and their coordination with drawing sheets
- Model-based annotation and tagging: dimension strings, keynotes, and tags linked to model elements so they update automatically when the model changes

Non Core

- Export formats for documentation delivery: PDF sets, DWG export for consultants without BIM authoring tools, and print/plot configuration for a full drawing set

Learning Outcomes:
Core:

1. Describe how a construction documentation set (plans, sections, elevations, schedules) is produced directly from a BIM model rather than drawn separately [Familiarity]
2. Produce a coordinated set of sheets, views, and schedules from a BIM model, keeping annotations and tags linked to model elements [Usage]
3. Evaluate a model-derived documentation set for completeness, internal consistency, and readiness for permit submission or construction [Assessment]

A.15.16 BIM/BIM Model Organization and Worksharing (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the internal organization of a BIM project file and the worksharing mechanics that let a team edit the same model concurrently.

Topics:

Core

- Project templates and file structure: starting templates, worksets, linked vs. inserted models, and project browser organization
- Naming and numbering conventions for models, sheets, and views, aligned with a project's BIM Execution Plan
- Worksharing mechanics: central/local file models, element ownership and borrowing, sync-with-central workflow, and conflict resolution between team members

Learning Outcomes:

Core:

1. Describe how a BIM project file is structured into worksets, links, and templates, and how multiple team members edit it concurrently through worksharing [Familiarity]
2. Set up a BIM project's worksets, naming conventions, and linked models for a multi-person team, and resolve a worksharing conflict [Usage]
3. Evaluate a BIM project's file organization and worksharing setup for consistency with its naming conventions and its ability to support concurrent editing [Assessment]

A.15.17 BIM/Generative Design and Optioneering (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of parametric and algorithmic methods to generate and compare multiple design options against quantifiable performance criteria.

Topics:

Core

- Generating design option sets through parametric variation of a model's driving dimensions, and organizing them for systematic comparison
- Performance-driven generative design: coupling a parametric model to a fitness metric (area efficiency, daylight, structural weight) via optimization plug-ins (Galapagos, Octopus)

Non Core

- Multi-objective optimization trade-offs: Pareto fronts for competing criteria, and interpreting optimization results for design decision-making

Learning Outcomes:

Core:

1. Describe how generative design couples a parametric model to a performance metric to produce and compare design options [Familiarity]
2. Set up a parametric model and an optimization plug-in to generate a set of design options against a chosen performance metric [Usage]
3. Evaluate a generative-design option set for the validity of its performance metric and the appropriateness of the selected design option [Assessment]

A.15.18 BIM/Model-Based Issue and RFI Management (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the tracking and resolution of design and construction issues through model-linked workflows, from clash markups to formal requests for information.

Topics:

Core

- BCF (BIM Collaboration Format)-based issue tracking: creating, assigning, and closing model-linked issues across authoring platforms
- Model-based requests for information (RFIs): linking an RFI to specific model elements and views, and tracking its resolution back into the model

- Submittal tracking tied to model elements: linking product data and shop-drawing submittals to the BIM elements they specify

Learning Outcomes:

Core:

1. Describe how BCF-based issue tracking, model-based RFIs, and submittal tracking keep design and construction issues linked to specific model elements [Familiarity]
2. Create, assign, and track a set of model-linked issues through BCF, and link a submittal or RFI to the model elements it affects [Usage]
3. Evaluate a project's model-based issue log for traceability, timely resolution, and completeness of the links between issues and model elements [Assessment]

A.15.19 BIM/BIM Across Project Delivery Methods (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers how different project delivery and procurement methods shape BIM use, responsibility, and maturity across a project's life.

Topics:

Core

- Project delivery methods and their effect on BIM responsibility: Design-Bid-Build, Design-Build, Construction Management at Risk, and Integrated Project Delivery (IPD)
- BIM maturity levels (Level 0-3): from unmanaged CAD to fully collaborative, cloud-based, integrated BIM, and how procurement choice shapes the achievable level

Non Core

- Risk- and reward-sharing models in IPD and alliance contracts, and their relationship to shared BIM model responsibility

Learning Outcomes:

Core:

1. Describe how different project delivery methods assign BIM responsibility differently, and explain the BIM maturity level framework [Familiarity]
2. Recommend a project delivery method and target BIM maturity level appropriate for a given project's scale and ownership structure [Usage]
3. Evaluate a project's chosen delivery method for whether it supports the BIM maturity level the project actually requires [Assessment]

A.15.20 BIM/Lean Construction and 4D BIM Integration (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the integration of Lean Construction planning methods with 4D BIM scheduling to reduce waste and improve the reliability of construction sequencing.

Topics:

Core

- Last Planner System: pull planning, weekly work plans, and percent-plan-complete (PPC) tracking, and its integration with a 4D BIM schedule
- Collaborative pull-planning sessions using 4D BIM visualizations to sequence trade work and identify constraints before they cause delay

Non Core

- Lean waste-reduction principles (overproduction, waiting, rework) applied to BIM-coordinated construction workflows

Learning Outcomes:

Core:

1. Describe the Last Planner System and explain how linking it to a 4D BIM schedule improves the reliability of construction sequencing [Familiarity]
2. Run a pull-planning exercise supported by a 4D BIM visualization, producing a weekly work plan and identifying constraints [Usage]
3. Evaluate a Lean-BIM construction plan for its percent-plan-complete tracking and its effectiveness at surfacing constraints before they cause delay [Assessment]

A.15.21 BIM/Fabrication-Level BIM Detailing (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the development of structural and MEP BIM models to fabrication-level detail (LOD 400) for shop drawings and prefabrication.

Topics:

Core

- Structural fabrication detailing: connection design, rebar detailing, and steel/precast shop-drawing-level modeling (Tekla, Advance Steel)
- MEP fabrication modeling: spool drawings for ductwork and piping, prefabrication-ready routing, and hanger/support detailing at LOD 400

Non Core

- Coordinating fabrication-level models with offsite prefabrication schedules and delivery logistics

Learning Outcomes:

Core:

1. Describe the difference between a construction-level (LOD 350) and a fabrication-level (LOD 400) structural or MEP model, and identify the detailing each requires [Familiarity]
2. Develop a structural connection or MEP routing detail to fabrication-level (LOD 400), ready for shop-drawing production [Usage]
3. Evaluate a fabrication-level BIM model for the completeness and buildability of its connection and routing details [Assessment]

A.15.22 BIM/BIM Model Quality Control and Auditing (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the systematic checking of a BIM model's data integrity, naming compliance, and modeling quality before it is shared or coordinated.

Topics:

Core

- Model auditing tools and routines: automated checks for unnamed/duplicate elements, orphaned families, and file size/performance issues
- Parameter and naming-convention validation: checking that model elements carry the required parameters and follow the project's naming standards before federation

Non Core

- Automated rule-checking scripts (Dynamo, Solibri rulesets) for enforcing modeling standards across a large or multi-author model

Learning Outcomes:

Core:

1. Describe the kinds of modeling and data errors a BIM quality-control audit is designed to catch, and why they matter before model federation [Familiarity]
2. Run a model audit on a BIM file, identifying and correcting naming, parameter, and modeling-quality issues before sharing it with the project team [Usage]
3. Evaluate a model's audit report to judge whether it is ready for federation and coordination, or requires further cleanup [Assessment]

A.15.23 BIM/BIM for Circular Economy and Material Reuse (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of BIM data to support circular-economy design decisions: deconstruction planning, material reuse, and end-of-life tracking.

Topics:

Core

- Design-for-disassembly principles embedded in BIM: reversible connections, material separation, and modeling components for future deconstruction

- Material passports and material banks: tagging BIM elements with reuse potential, provenance, and end-of-life data for future material recovery

Non Core

- Deconstruction sequencing and planning using a BIM model, mirroring 4D construction scheduling in reverse

Learning Outcomes:

Core:

1. Describe how BIM data (material passports, reversible-connection tagging) can support circular-economy design decisions [Familiarity]
2. Tag a BIM model's elements with material-passport and design-for-disassembly data to support a future deconstruction or reuse scenario [Usage]
3. Evaluate a BIM-based circular-economy strategy for a project, judging the completeness of its material-passport data and the feasibility of its deconstruction plan [Assessment]

A.15.24 BIM/BIM-Supported Green Building Certification (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the use of BIM model data to track and document compliance with green-building certification systems throughout design and construction.

Topics:

Core

- Certification credit tracking from model data: linking BIM quantities and performance analysis results to LEED, EDGE, or BREEAM credit requirements
- Generating certification documentation (narratives, calculations, drawings) directly from BIM model data and schedules

Learning Outcomes:

Core:

1. Describe how BIM model data can be linked to green-building certification credit requirements and documentation [Familiarity]
2. Track a chosen set of green-building certification credits against a BIM model's quantities and analysis results [Usage]
3. Evaluate a BIM-based certification compliance package for completeness and consistency with the model it was generated from [Assessment]

A.15.25 BIM/Operational Digital Twins from BIM (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the evolution of an as-built BIM model into a live operational digital twin through sensor integration and performance monitoring.

Topics:

Core

- IoT sensor integration with an as-built BIM model: mapping sensor feeds (temperature, occupancy, energy use) to model elements and spaces
- Predictive-maintenance workflows: using live and historical operational data linked to a digital twin to anticipate equipment failure and schedule maintenance

Non Core

- Building performance dashboards built on digital-twin data for facilities managers and building owners

Learning Outcomes:

Core:

1. Describe how an as-built BIM model becomes a live operational digital twin through sensor integration and ongoing data feeds [Familiarity]
2. Map a set of IoT sensor feeds to an as-built BIM model's spaces and elements, and build a simple performance dashboard from the resulting data [Usage]
3. Evaluate a building's digital-twin setup for sensor coverage, data quality, and its usefulness for predictive maintenance [Assessment]

A.15.26 BIM/Asset Classification and Data Standards for FM (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the classification systems and data schemas that structure asset information for facilities management, independent of any one software platform.

Topics:

Core

- Asset classification systems: Uniclass and OmniClass structures for organizing building elements and systems for FM use
- COBie schema in depth: component, type, system, space, and spare-parts worksheets, and how FM software consumes them

Learning Outcomes:

Core:

1. Describe how classification systems (Uniclass, OmniClass) and the COBie schema structure asset data for facilities management [Familiarity]
2. Classify a BIM model's assets using a standard classification system, and populate the corresponding COBie worksheets [Usage]
3. Evaluate an asset data set for correct classification and COBie schema completeness before FM handover [Assessment]

A.15.27 BIM/Reality Capture for BIM: Point Clouds and Photogrammetry (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the capture and processing of real-world geometry (laser scanning, photogrammetry) into point-cloud and mesh data usable as a BIM modeling reference.

Topics:

Core

- Laser scanning workflows: terrestrial and handheld scanner data capture, registration of multiple scans, and point-cloud cleanup
- Photogrammetric reconstruction: structure-from-motion processing of overlapping photographs (drone or handheld) into dense point clouds and textured meshes
- Working from point-cloud or mesh references inside a BIM authoring tool: underlay referencing, scan-based dimension checking, and as-built verification against design models

Learning Outcomes:

Core:

1. Describe how laser scanning and photogrammetry capture real-world geometry as point-cloud or mesh data usable inside a BIM authoring tool [Familiarity]
2. Register a set of scans or photographs into a point cloud, and use it as a reference to verify or model an as-built condition in BIM [Usage]
3. Evaluate a reality-capture data set for registration accuracy and its adequacy as a reference for as-built BIM modeling [Assessment]

A.15.28 BIM/Integrated BIM Project Delivery (Capstone) (Core Tier1: 1 hr, Core Tier2: 1 hr)

Covers the end-to-end integration of authoring, coordination, scheduling/cost, and facilities-management BIM workflows into a single project deliverable.

Topics:

Core

- Integrating a project's full BIM workflow: authoring, federation and clash resolution, 4D/5D linkage, and FM-ready handover data, delivered as a single coherent package
- Executing a BIM Execution Plan end to end on a real project deliverable, tracking its stated BIM goals and LOD matrix against what was actually produced

Learning Outcomes:

Core:

1. Describe how a BIM Execution Plan's stated goals connect authoring, coordination, scheduling/cost, and FM handover into a single integrated project workflow [Familiarity]
2. Deliver an integrated BIM project package covering authoring, coordination, 4D/5D data, and FM handover, following a stated BIM Execution Plan [Usage]
3. Evaluate an integrated BIM project deliverable against its own BIM Execution Plan, judging completeness and internal consistency across authoring, coordination, and handover data [Assessment]

A.15.29 BIM/Emerging Trends in BIM Practice

Surveys emerging research and practice directions that extend BIM beyond its current established workflows.

Topics:

Non Core

- Urban-scale digital twins combining building BIM, infrastructure BIM, and city-scale sensor networks for planning and resilience analysis
- Blockchain and distributed-ledger proposals for BIM model provenance, version authenticity, and smart contracts tied to model milestones
- Convergence of BIM with construction robotics and autonomous site monitoring, extending the AI-assisted automation already covered in BIM.AIAutomation

Learning Outcomes:

NonCore:

1. Describe two or three emerging research or practice directions that are extending BIM beyond its current established workflows [Familiarity]
2. Discuss, with supporting evidence, the practical maturity and adoption barriers of one emerging BIM trend [Usage]
3. Evaluate the likely near-term impact of an emerging BIM trend on professional practice in the student's own context [Assessment]

A.15.30 BIM/BIM Software Practicum (Core Tier1: 1 hr, Core Tier2: 1 hr)

A transversal, hands-on software-lab component that recurs across the BIM course sequence: guided exercises and certification-aligned practice in the specific authoring/coordination/analysis tool relevant to each course's theme.

Topics:

Core

- Guided, graded software exercises in the BIM tool(s) specific to the course's theme (authoring, coordination, scheduling, analysis, or FM platforms), building toward a cumulative course deliverable
- Practice aligned with vendor or industry certification exams (Autodesk Certified Professional, buildingSMART openBIM) relevant to the course's software focus

Learning Outcomes:

Core:

1. Describe the practicum structure for the course's BIM software focus and the deliverable it builds toward [Familiarity]
2. Complete a sequence of guided exercises in the course's BIM software focus, building toward a cumulative practicum deliverable [Usage]
3. Evaluate the student's own practicum deliverable against the software proficiency expected for the course's BIM theme [Assessment]

Appendix B

Body of knowledge of Architectural Sciences

The 8 knowledge areas in Architectural Sciences are:

B.1 Calculus and Analysis (CAN) (Pg.. 289)
- B.1.1 Limits and Continuity (Pg.. 290)
- B.1.2 Differential Calculus (Pg.. 290)
- B.1.3 Integral Calculus (Pg.. 290)
- B.1.4 Improper Integrals (Pg.. 290)
- B.1.5 Sequences, Series, and Power Series (Pg.. 291)
- B.1.6 Applications of the Definite Integral (Pg.. 291)
- B.1.7 Vectors and the Geometry of Space (Pg.. 291)
- B.1.8 Quadric Surfaces (Pg.. 291)
- B.1.9 Parametric Equations and Polar Coordinates (Pg.. 292)
- B.1.10 Multivariable and Vector Calculus (Pg.. 292)

B.2 Algebra and Number Theory (ANT) (Pg.. 292)
- B.2.1 Matrices and Systems of Linear Equations (Pg.. 293)
- B.2.2 Vector Spaces and Linear Transformations (Pg.. 293)

B.3 Geometry and Topology (GTO) (Pg.. 293)
- B.3.1 Euclidean and Projective Geometry (Pg.. 293)
- B.3.2 Differential Geometry of Curves and Surfaces (Pg.. 294)

B.4 Classical Mechanics (CME) (Pg.. 294)
- B.4.1 Kinematics and Dynamics of Particles (Pg.. 294)
- B.4.2 Rotational Motion and Angular Momentum (Pg.. 295)
- B.4.3 Elasticity (Pg.. 295)
- B.4.4 Fluids: Hydrostatics, Hydrodynamics, and Viscosity (Pg.. 296)
- B.4.5 Vibrations and Waves (Pg.. 296)
- B.4.6 Transport Phenomena (Pg.. 297)

B.5 Probability Theory (PRO) (Pg.. 297)
- B.5.1 Probability Axioms and Properties (Pg.. 297)
- B.5.2 Conditional Probability and Independence (Pg.. 298)
- B.5.3 Discrete Random Variables and Distributions (Pg.. 298)
- B.5.4 Continuous Random Variables and Distributions (Pg.. 298)
- B.5.5 Limit Theorems: LLN and CLT (Pg.. 299)

B.6 Descriptive Statistics and Data Analysis (DSC) (Pg.. 299)
- B.6.1 Numerical Summaries: Location, Spread, and Shape (Pg.. 299)

B.7 Statistical Inference (INF) (Pg.. 300)
- B.7.1 Point Estimation (Pg.. 300)
- B.7.2 Interval Estimation and Confidence Intervals (Pg.. 300)
- B.7.3 Hypothesis Testing Foundations (Pg.. 300)

B.8 Regression and Statistical Models (REG) (Pg.. 301)
- B.8.1 Simple Linear Regression (Pg.. 301)

B.1 Calculus and Analysis (CAN)

This area covers the fundamental study of change, limits, and the rigorous properties of functions. It spans from basic differentiation and integration to advanced measure theory and functional spaces, providing the essential toolkit for all mathematical modeling.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.1.1 Limits and Continuity (Pg.. 290)	1	1
⭐ B.1.2 Differential Calculus (Pg.. 290)	1	1
⭐ B.1.3 Integral Calculus (Pg.. 290)	1	1
⭐ B.1.4 Improper Integrals (Pg.. 290)	1	1
⭐ B.1.5 Sequences, Series, and Power Series (Pg.. 291)	1	1
⭐ B.1.6 Applications of the Definite Integral (Pg.. 291)	1	1
⭐ B.1.7 Vectors and the Geometry of Space (Pg.. 291)	1	1
⭐ B.1.8 Quadric Surfaces (Pg.. 291)	1	1
⭐ B.1.9 Parametric Equations and Polar Coordinates (Pg.. 292)	1	1
⭐ B.1.10 Multivariable and Vector Calculus (Pg.. 292)	1	1

Table B.1: List of KUs in the Calculus and Analysis area.

B.1.1 CAN/Limits and Continuity (Core Tier1: 1 hr, Core Tier2: 1 hr)

Limits and continuity of single-variable functions, the foundation for rigorously studying change in architectural systems.

Topics:

Core

- Limits and continuity of single-variable functions

Learning Outcomes:

Core:

1. Interpret the concept of limit and continuity of a function and its relevance to modeling the behavior of architectural systems near a point [Familiarity]

B.1.2 CAN/Differential Calculus (Core Tier1: 1 hr, Core Tier2: 1 hr)

Derivatives and rules of differentiation, with applications to architectural design and optimization.

Topics:

Core

- Derivatives and rules of differentiation

Learning Outcomes:

Core:

1. Apply differentiation rules to find rates of change and optimize architectural design parameters [Usage]
2. Formulate and solve optimization problems for architectural systems using differential calculus [Assessment]

B.1.3 CAN/Integral Calculus (Core Tier1: 1 hr, Core Tier2: 1 hr)

The Fundamental Theorem of Calculus, integration techniques, and their applications to architectural problems.

Topics:

Core

- The Fundamental Theorem of Calculus
- Integration techniques including substitution and parts
- Architectural applications of integration: areas, volumes, centroids, and moments of inertia

Learning Outcomes:

Core:

1. State and explain the Fundamental Theorem of Calculus [Familiarity]
2. Calculate definite integrals arising from architectural problems such as work, fluid pressure, and heat transfer [Usage]

B.1.4 CAN/Improper Integrals (Core Tier1: 1 hr, Core Tier2: 1 hr)

Integrals over unbounded intervals or of unbounded functions, and the convergence criteria architects use to determine whether such quantities (e.g. total impulse, accumulated decay) are finite.

Topics:

Core

- Improper integrals over unbounded intervals
- Improper integrals of unbounded (discontinuous) integrands
- Convergence criteria and comparison tests for improper integrals

Learning Outcomes:

Core:

1. Determine whether an improper integral arising from an architectural model converges, using comparison and other convergence tests [Assessment]
2. Evaluate an improper integral by taking the appropriate limit, when it converges [Usage]

B.1.5 CAN/Sequences, Series, and Power Series (Core Tier1: 1 hr, Core Tier2: 1 hr)

Convergence of infinite sequences and series and the power-series (Taylor/Maclaurin) approximations architects use to model, linearize, and numerically evaluate functions.

Topics:

Core

- Sequences and series: convergence tests (ratio, root, comparison, integral)
- Power series, radius of convergence, and Taylor/Maclaurin series
- Architectural use of Taylor polynomials for linearization and numerical approximation

Learning Outcomes:

Core:

1. Determine convergence of a power series and construct a Taylor series for a standard architectural function [Assessment]
2. Apply a Taylor polynomial to approximate or linearize an architectural function [Usage]

B.1.6 CAN/Applications of the Definite Integral (Core Tier1: 1 hr, Core Tier2: 1 hr)

Geometric and physical applications of the definite integral: areas, volumes of revolution, arc length, and work, as architectural computations built on integral calculus.

Topics:

Core

- Area between curves by integrating with respect to x or y
- Volume of solids of revolution by the disk and washer method
- Volume of solids of revolution by the cylindrical shell method
- Work via integration (springs, pumping fluids, cables)

Elective

- Moments and centroid of a plane region or solid

Learning Outcomes:

Core:

1. Calculate the volume of a solid of revolution using the disk, washer, or cylindrical shell method [Usage]
2. Calculate the work done by a variable force using integration [Usage]

B.1.7 CAN/Vectors and the Geometry of Space (Core Tier1: 1 hr, Core Tier2: 1 hr)

Vectors in three-dimensional space, the dot and cross products, and their application to lines and planes, the basis of vector analysis in statics and dynamics.

Topics:

Core

- Dot and cross products: definition, properties, and geometric interpretation
- Equations of lines and planes in space

Learning Outcomes:

Core:

1. Compute the dot and cross products of vectors to solve architectural force and moment problems [Usage]
2. Determine equations of lines and planes in space from the geometric data of an architectural problem [Usage]

B.1.8 CAN/Quadric Surfaces (Core Tier1: 1 hr, Core Tier2: 1 hr)

Classification of quadric surfaces, used to describe component geometries and surfaces in architectural modeling.

Topics:
Core
- Classification of quadrics (ellipsoids, paraboloids, hyperboloids) from their general equation

Learning Outcomes:
Core:
1. Classify a quadric surface and identify its geometry for architectural component modeling [Usage]

B.1.9 CAN/Parametric Equations and Polar Coordinates (Core Tier1: 1 hr, Core Tier2: 1 hr)

Parametric curves and polar coordinates, used to describe trajectories and geometries in kinematics and architectural design.
Topics:
Core
- Parametric curves and their calculus, applied to trajectories in kinematics
- Polar coordinates and their conversion to Cartesian coordinates

Learning Outcomes:
Core:
1. Calculate the velocity and acceleration of a trajectory described parametrically [Usage]
2. Convert between polar and Cartesian coordinates when modeling architectural geometries [Usage]

B.1.10 CAN/Multivariable and Vector Calculus (Core Tier1: 1 hr, Core Tier2: 1 hr)

Calculus of functions of several variables, focusing on partial derivatives, multiple integrals, and vector field theorems essential for field analysis in architecture.
Topics:
Core
- Partial derivatives and the gradient vector
- Multiple integrals in Cartesian, cylindrical, and spherical coordinate systems
- Vector fields and line and surface integrals
- Integral theorems: Green, Stokes, and the Divergence Theorem
- Applications to flux, circulation, and conservative fields in architectural contexts

Learning Outcomes:
Core:
1. Compute gradients and directional derivatives for scalar fields describing physical quantities [Usage]
2. Evaluate double and triple integrals for volumes, masses, and centroids of architectural objects [Usage]
3. Apply Stokes' and Gauss's Divergence Theorems to relate field integrals in electromagnetism and fluid mechanics [Assessment]
4. Determine whether a vector force field is conservative and compute the potential function [Assessment]

B.2 Algebra and Number Theory (ANT)

Structural properties of mathematical systems including linear systems, abstract algebraic structures, and properties of integers.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.2.1 Matrices and Systems of Linear Equations (Pg.. 293)	1	1
⭐ B.2.2 Vector Spaces and Linear Transformations (Pg.. 293)	1	1

Table B.2: List of KUs in the Algebra and Number Theory area.

B.2.1 ANT/Matrices and Systems of Linear Equations (Core Tier1: 1 hr, Core Tier2: 1 hr)

Matrix factorization and solution of architectural linear systems via LU, QR, Cholesky, and SVD decompositions.

Topics:

Core

- LU, QR, and Cholesky factorizations for solving architectural linear systems
- Singular Value Decomposition (SVD) and least squares solutions

Learning Outcomes:

Core:

1. Solve systems of linear equations arising in structural, circuit, and fluid architectural problems [Usage]
2. Apply the SVD to solve over-determined systems in data fitting and signal processing [Usage]

B.2.2 ANT/Vector Spaces and Linear Transformations (Core Tier1: 1 hr, Core Tier2: 1 hr)

Vector spaces and linear transformations with applications to architectural coordinate changes.

Topics:

Core

- Vector spaces, subspaces, bases, and dimension
- Linear transformations and their matrix representations in coordinate changes

Learning Outcomes:

Core:

1. Formulate and interpret coordinate system transformations for architectural geometry problems [Assessment]

B.3 Geometry and Topology (GTO)

This area covers the study of shape, space, and continuity, ranging from classical Euclidean geometry to the modern theory of manifolds, algebraic topology, and symplectic geometry, with deep connections to physics and data science.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.3.1 Euclidean and Projective Geometry (Pg.. 293)	1	1
⭐ B.3.2 Differential Geometry of Curves and Surfaces (Pg.. 294)	1	1

Table B.3: List of KUs in the Geometry and Topology area.

B.3.1 GTO/Euclidean and Projective Geometry (Core Tier1: 1 hr, Core Tier2: 1 hr)

Axiomatic Euclidean geometry, isometries, symmetry groups, and the projective plane.

Topics:

Core

- Euclidean geometry: axioms, congruence, similarity, and classical theorems
- Isometries of the plane and space: reflections, rotations, translations, and glide reflections
- Symmetry groups: frieze groups, wallpaper groups, and the classification of finite isometry groups
- Projective plane: homogeneous coordinates, duality, and cross-ratio
- Conic sections in projective geometry: classification and projective transformations

Learning Outcomes:
Core:

1. Describe the axiomatic foundation of Euclidean geometry and identify the role of the parallel postulate [Familiarity]
2. Classify isometries of the plane and determine the symmetry group of a given geometric figure [Usage]
3. Apply projective coordinates and duality to prove classical theorems (Pappus, Desargues) [Assessment]

B.3.2 GTO/Differential Geometry of Curves and Surfaces (Core Tier1: 1 hr, Core Tier2: 1 hr)

Local and global theory of curves and surfaces in $\mathbb{R}^3$: curvature, Gauss map, and the Gauss-Bonnet theorem.
Topics:
Core

- Space curves: curvature, torsion, Frenet-Serret frame, and the fundamental theorem of curves
- Regular surfaces in $\mathbb{R}^3$: parametrizations, tangent planes, and first fundamental form
- Second fundamental form, principal curvatures, Gaussian and mean curvature, and the Gauss map
- Geodesics on surfaces and the Gauss-Bonnet theorem
- Gauss's Theorema Egregium: intrinsic nature of Gaussian curvature

Learning Outcomes:
Core:

1. Compute the curvature and torsion of a space curve from its parametric equations [Familiarity]
2. Calculate the Gaussian and mean curvature of parametric surfaces using the first and second fundamental forms [Usage]
3. Apply the Gauss-Bonnet theorem to relate the curvature of a surface to its topological Euler characteristic [Assessment]

B.4 Classical Mechanics (CME)

Classical Mechanics provides the foundational principles governing the motion of macroscopic objects, from particles to rigid bodies and continuous media. It encompasses Newtonian dynamics, conservation laws, Lagrangian and Hamiltonian formalisms, oscillatory systems, and celestial mechanics.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.4.1 Kinematics and Dynamics of Particles (Pg.. 294)	1	1
⭐ B.4.2 Rotational Motion and Angular Momentum (Pg.. 295)	1	1
⭐ B.4.3 Elasticity (Pg.. 295)	1	1
⭐ B.4.4 Fluids: Hydrostatics, Hydrodynamics, and Viscosity (Pg.. 296)	1	1
⭐ B.4.5 Vibrations and Waves (Pg.. 296)	1	1
⭐ B.4.6 Transport Phenomena (Pg.. 297)	1	1

Table B.4: List of KUs in the Classical Mechanics area.

B.4.1 CME/Kinematics and Dynamics of Particles (Core Tier1: 1 hr, Core Tier2: 1 hr)

Mathematical description of motion and the study of forces that cause or modify motion for point particles, forming the basis of mechanical and structural architectural analysis.
Topics:
Core

- Vector description of position, velocity, and acceleration in Cartesian, polar, and spherical coordinates

- Newton's three laws of motion and inertial reference frames
- Formulation and solution of equations of motion for constant and variable forces
- Static and kinetic friction forces, including angle of repose
- Numerical integration of equations of motion for architectural dynamics problems

Learning Outcomes:

Core:

1. Formulate the equations of motion for a particle in one, two, and three dimensions given a force law [Usage]
2. Identify all forces acting on a particle and draw a correct free-body diagram [Familiarity]
3. Calculate the terminal velocity of an object falling through a fluid with drag resistance [Assessment]
4. Implement a numerical algorithm to simulate the dynamics of an architectural mechanical system [Usage]
5. Construct and interpret phase space diagrams for simple architectural oscillatory systems [Assessment]

B.4.2 CME/Rotational Motion and Angular Momentum (Core Tier1: 1 hr, Core Tier2: 1 hr)

Rotational kinematics and dynamics, torque, moment of inertia, rotational energy, and conservation of angular momentum for architectural machines and structures.

Topics:

Core

- Rotational kinematics: angular displacement, velocity, and acceleration
- Torque: $\vec{\tau} = \vec{r} \times \vec{F}$ and its computation
- Moment of inertia $I = \sum m_i r_i^2$ and the parallel axis theorem
- Rotational kinetic energy: $K_{rot} = \frac{1}{2} I \omega^2$
- Conservation of angular momentum in architectural machines and rotating structures
- Rolling without slipping dynamics and applications to wheels and shafts

Learning Outcomes:

Core:

1. Calculate torque about a given axis for an architectural power transmission system [Usage]
2. Determine the moment of inertia for machine components such as rods, disks, and shafts [Usage]
3. Apply conservation of angular momentum to analyze speed changes in rotating architectural systems [Assessment]
4. Analyze combined translational and rotational motion in wheeled architectural systems [Assessment]

B.4.3 CME/Elasticity (Core Tier1: 1 hr, Core Tier2: 1 hr)

Elastic properties of solids under axial, shear, and volumetric load: stress, strain, and scalar elastic moduli.

Topics:

Core

- Definition of stress (force/area) and strain ($\Delta L/L$)
- Young's modulus and Hooke's law for longitudinal strain: $\sigma = E\epsilon$
- Shear modulus (rigidity) and shear strain
- Bulk modulus (compressibility) and volumetric strain
- Elastic limit, plastic region, and fracture point on the stress-strain diagram

Elective

- Elastic energy stored in a deformed material

Learning Outcomes:

Core:

1. Apply the scalar Hooke's law to calculate the deformation of a rod under axial load [Usage]
2. Calculate Young's, shear, or bulk modulus from experimental stress-strain data [Usage]
3. Identify the elastic region, elastic limit, and fracture point on a stress-strain curve [Familiarity]

Elective:

4. Calculate the elastic potential energy stored in a deformed spring or rod [Usage]

B.4.4 CME/Fluids: Hydrostatics, Hydrodynamics, and Viscosity (Core Tier1: 1 hr, Core Tier2: 1 hr)

Statics and dynamics of incompressible fluids: pressure, buoyancy, the continuity and Bernoulli equations, and an introduction to viscous flow.

Topics:

Core

- Density, pressure, and its variation with depth in a fluid at rest: $p = p_0 + \rho g h$
- Pascal's principle and its applications (hydraulic press)
- Archimedes' principle, buoyant force, and flotation
- Pressure measurement with manometers and barometers
- Continuity equation for incompressible flow: $A_1 v_1 = A_2 v_2$
- Bernoulli's equation and energy conservation in ideal flow
- Applications: Venturi tube, Torricelli's theorem, Pitot tube

Elective

- Viscosity and Poiseuille's law for laminar flow in pipes
- Reynolds number and the transition to turbulent flow
- Stokes' law for the drag force on a sphere in a viscous fluid

Learning Outcomes:

Core:

1. Calculate the pressure at a point in a fluid at rest given depth and density [Usage]
2. Apply Archimedes' principle to determine whether an object floats, sinks, or remains in equilibrium [Usage]
3. Apply the continuity and Bernoulli equations to solve flow problems in pipes of varying cross-section [Usage]
4. Interpret manometer and barometer readings to determine absolute and gauge pressures [Assessment]

Elective:

5. Apply Poiseuille's law to calculate the flow rate of a viscous fluid in a cylindrical tube [Usage]
6. Estimate the Reynolds number of a flow and predict whether it is laminar or turbulent [Assessment]

B.4.5 CME/Vibrations and Waves (Core Tier1: 1 hr, Core Tier2: 1 hr)

Simple harmonic motion, damped and forced oscillations, and the propagation, superposition, and resonance of mechanical waves.

Topics:

Core

- Simple harmonic motion (SHM): equation of motion, position, velocity, and acceleration
- Oscillating systems: spring-mass and simple/physical pendulum
- Energy in simple harmonic motion
- Damped and forced oscillations; introduction to resonance
- Transverse and longitudinal waves; propagation speed
- Wave equation and speed of a wave on a taut string: $v = \sqrt{T/\mu}$
- Superposition principle and standing waves
- Sound waves, intensity, and sound intensity level (decibels)

Elective

- Doppler effect for sound waves
- Beats and interference of waves of nearby frequencies

Learning Outcomes:

Core:

1. Derive the equation of motion and the period of a spring-mass system and a simple pendulum [Usage]

2. Calculate the kinetic, potential, and total energy of a simple harmonic oscillator at any instant [Usage]
3. Analyze the amplitude response of a forced oscillator near the resonance frequency [Assessment]
4. Calculate the propagation speed of a wave on a string from the tension and linear density [Usage]
5. Determine the frequencies and wavelengths of the normal modes of a standing wave on a fixed string [Usage]
6. Calculate the sound intensity level in decibels from the intensity of a sound wave [Usage]

Elective:

7. Apply the Doppler effect formula for a moving source and/or observer [Usage]

B.4.6 CME/Transport Phenomena (Core Tier1: 1 hr, Core Tier2: 1 hr)

Introduction to transport phenomena in continuous media: heat conduction and mass diffusion as gradient-driven flux processes.

Topics:

Core

- Heat conduction and Fourier's law: $\vec{q} = -k\nabla T$
- Thermal conductivity of materials and thermal resistance in composite walls
- Molecular diffusion and Fick's first law: $\vec{J} = -D\nabla C$

Elective

- Analogy between heat, mass, and momentum transport (Prandtl and Schmidt numbers)

Learning Outcomes:

Core:

1. Apply Fourier's law to calculate the heat flux through a plane or composite wall [Usage]
2. Apply Fick's first law to calculate the diffusive flux of a species in a concentration gradient [Usage]

Elective:

3. Identify mathematical analogies between heat, mass, and momentum transport processes [Familiarity]

B.5 Probability Theory (PRO)

This knowledge area covers the mathematical foundations of probability, including sample spaces, random variables, probability distributions, joint distributions, moments, transformations, and the fundamental limit theorems. It provides the theoretical basis for all of statistical inference and modeling.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.5.1 Probability Axioms and Properties (Pg.. 297)	1	1
⭐ B.5.2 Conditional Probability and Independence (Pg.. 298)	1	1
⭐ B.5.3 Discrete Random Variables and Distributions (Pg.. 298)	1	1
⭐ B.5.4 Continuous Random Variables and Distributions (Pg.. 298)	1	1
⭐ B.5.5 Limit Theorems: LLN and CLT (Pg.. 299)	1	1

Table B.5: List of KUs in the Probability Theory area.

B.5.1 PRO/Probability Axioms and Properties (Core Tier1: 1 hr, Core Tier2: 1 hr)

Kolmogorov's axioms of probability and derived properties. Covers classical, frequentist, and subjective interpretations of probability and their implications.

Topics:

Core

- Kolmogorov's three axioms of probability and their consequences

- Derived properties: complement rule, addition rule, monotonicity, and continuity of probability

- Classical, frequentist, and subjective (Bayesian) interpretations of probability
- Counting methods: permutations, combinations, and the multiplication principle

Learning Outcomes:

Core:

1. State Kolmogorov's axioms and derive fundamental probability properties [Familiarity]
2. Calculate probabilities of events using the addition rule and complement rule [Usage]
3. Apply counting methods to compute probabilities in finite sample spaces [Usage]

B.5.2 PRO/Conditional Probability and Independence (Core Tier1: 1 hr, Core Tier2: 1 hr)

Conditional probability, the multiplication rule, the law of total probability, Bayes' theorem, and the concept of independence between events and collections of events.

Topics:

Core

- Definition and interpretation of conditional probability P(A|B) and its properties
- Bayes' theorem and the law of total probability: derivation and applications
- Independence of events: pairwise and mutual independence
- Conditional independence and its role in probabilistic graphical models

Learning Outcomes:

Core:

1. Explain conditional probability and independence and their relationship [Familiarity]
2. Apply Bayes' theorem and the law of total probability to solve probability problems [Usage]
3. Analyze whether events are independent or conditionally independent in a given probability model [Assessment]

B.5.3 PRO/Discrete Random Variables and Distributions (Core Tier1: 1 hr, Core Tier2: 1 hr)

Random variables as measurable functions, probability mass functions, cumulative distribution functions, and the most important discrete probability distributions.

Topics:

Core

- Probability mass functions (PMF) and cumulative distribution functions (CDF) for discrete random variables
- Key discrete distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Poisson, Hypergeometric
- Properties of discrete distributions: mean, variance, skewness, and kurtosis
- Poisson approximation to the Binomial and limiting distribution arguments

Learning Outcomes:

Core:

1. Identify and describe the key discrete probability distributions and their parameters [Familiarity]
2. Calculate probabilities, means, and variances using PMFs of standard discrete distributions [Usage]
3. Select an appropriate discrete distribution to model a given random phenomenon and justify the choice [Assessment]

B.5.4 PRO/Continuous Random Variables and Distributions (Core Tier1: 1 hr, Core Tier2: 1 hr)

Probability density functions, CDFs, and the most important continuous probability distributions used in statistical theory and practice.

Topics:

Core

- Probability density functions (PDF) and CDFs for continuous random variables
- Key continuous distributions: Uniform, Normal, Exponential, Gamma, Beta, Chi-squared, t, F
- The Normal distribution: properties, standard normal, and its central role in statistical inference

- The exponential family of distributions: canonical form and sufficient statistics

Learning Outcomes:

Core:

1. Describe the properties and parameters of key continuous probability distributions [Familiarity]
2. Calculate probabilities and quantiles for standard continuous distributions [Usage]
3. Identify distributions belonging to the exponential family and derive their sufficient statistics [Assessment]

B.5.5 PRO/Limit Theorems: LLN and CLT (Core Tier1: 1 hr, Core Tier2: 1 hr)

The laws of large numbers and the central limit theorem as the mathematical justification for statistical estimation and inference procedures based on large samples.

Topics:

Core

- Weak law of large numbers: convergence in probability and its implications for estimation
- Central limit theorem: statement, conditions, and role in justifying normal approximations
- Applications of the CLT: normal approximation to the binomial and sampling distributions
- Strong law of large numbers: almost sure convergence
- The delta method: asymptotic distribution of smooth functions of estimators

Learning Outcomes:

Core:

1. State the LLN and CLT and explain the conditions under which they hold [Familiarity]
2. Apply the CLT to derive normal approximations and sampling distributions [Usage]
3. Apply the delta method to derive asymptotic distributions of nonlinear estimators [Assessment]

B.6 Descriptive Statistics and Data Analysis (DSC)

This knowledge area covers methods for summarizing, visualizing, and exploring data. It includes numerical and graphical summaries, exploratory data analysis, data quality assessment, and communication of statistical findings.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.6.1 Numerical Summaries: Location, Spread, and Shape (Pg.. 299)	1	1

Table B.6: List of KUs in the Descriptive Statistics and Data Analysis area.

B.6.1 DSC/Numerical Summaries: Location, Spread, and Shape (Core Tier1: 1 hr, Core Tier2: 1 hr)

Measures of central tendency, dispersion, and distributional shape. Includes robust alternatives and the interpretation of numerical summaries in context.

Topics:

Core

- Measures of location: mean, median, mode, trimmed mean, and weighted mean
- Measures of spread: variance, standard deviation, IQR, MAD, and range
- Measures of shape: skewness and kurtosis; quantiles and percentiles
- Robust summary statistics: resistance to outliers and heavy-tailed distributions

Learning Outcomes:

Core:

1. Calculate and interpret measures of location, spread, and shape for a univariate dataset [Usage]
2. Select appropriate summary statistics based on the distributional properties of the data [Usage]

3. Compare classical and robust summary statistics and justify the choice for a given dataset [Assessment]

B.7 Statistical Inference (INF)

This knowledge area covers the foundations and methods of statistical inference: point and interval estimation, hypothesis testing, likelihood theory, Bayesian inference, nonparametric methods, multiple testing, and large-sample theory. It is the core of classical and modern statistics.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.7.1 Point Estimation (Pg.. 300)	1	1
⭐ B.7.2 Interval Estimation and Confidence Intervals (Pg.. 300)	1	1
⭐ B.7.3 Hypothesis Testing Foundations (Pg.. 300)	1	1

Table B.7: List of KUs in the Statistical Inference area.

B.7.1 INF/Point Estimation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Methods for estimating unknown parameters from data. Covers desirable properties of estimators, method of moments, maximum likelihood estimation, and the Cramer-Rao lower bound.
Topics:
Core

- Desirable properties: unbiasedness, consistency, efficiency, and sufficiency
- Method of moments estimation: derivation and asymptotic properties
- Maximum likelihood estimation: derivation, properties, and invariance principle
- Cramer-Rao lower bound and the concept of Fisher information

Learning Outcomes:
Core:

1. Describe the key properties of estimators and explain the trade-offs between them [Familiarity]
2. Derive method of moments and MLE estimators for standard distributions [Usage]
3. Evaluate the efficiency of an estimator using the Cramer-Rao lower bound [Assessment]

B.7.2 INF/Interval Estimation and Confidence Intervals (Core Tier1: 1 hr, Core Tier2: 1 hr)

Construction and interpretation of confidence intervals. Covers pivotal quantity method, large-sample intervals, and the relationship between confidence intervals and hypothesis tests.
Topics:
Core

- Constructing confidence intervals using pivotal quantities and exact distributions
- Correct interpretation of confidence intervals: coverage probability and common misconceptions
- Large-sample confidence intervals based on asymptotic normality
- Duality between confidence intervals and hypothesis tests

Learning Outcomes:
Core:

1. Construct confidence intervals for means, proportions, and variances using exact and large-sample methods [Usage]
2. Interpret confidence intervals correctly and identify common misinterpretations [Usage]
3. Explain the duality between confidence intervals and hypothesis tests and use it to draw inferences [Assessment]

B.7.3 INF/Hypothesis Testing Foundations (Core Tier1: 1 hr, Core Tier2: 1 hr)

The Neyman-Pearson framework for hypothesis testing: null and alternative hypotheses, Type I and II errors, power, p-values, and the most powerful tests.

Topics:
Core
- Neyman-Pearson framework: null/alternative hypotheses, rejection regions, Type I and II errors
- p-values: definition, correct interpretation, and common misuse; power and sample size
- Common parametric tests: z-test, t-test, F-test, chi-squared test
- Neyman-Pearson lemma and uniformly most powerful tests

Learning Outcomes:
Core:
1. Explain the logic of hypothesis testing, Type I and II errors, and the meaning of a p-value [Familiarity]
2. Apply standard parametric tests and interpret the results in context [Usage]
3. Derive the most powerful test for a simple hypothesis using the Neyman-Pearson lemma [Assessment]

B.8 Regression and Statistical Models (REG)

This knowledge area covers the construction, estimation, interpretation, and validation of statistical models for relationships between variables. It spans simple and multiple linear regression, generalized linear models, nonparametric regression, mixed models, and causal inference.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ B.8.1 Simple Linear Regression (Pg.. 301)	1	1

Table B.8: List of KUs in the Regression and Statistical Models area.

B.8.1 REG/Simple Linear Regression (Core Tier1: 1 hr, Core Tier2: 1 hr)

The simple linear regression model: least squares estimation, inference for coefficients, model fit, and the assumptions of the classical linear model.
Topics:
Core
- Ordinary least squares estimation: derivation of coefficients and their properties
- Inference for regression coefficients: t-tests, confidence intervals, and p-values
- Coefficient of determination R-squared and analysis of variance decomposition
- Gauss-Markov theorem: BLUE property of OLS under classical assumptions

Learning Outcomes:
Core:
1. Fit a simple linear regression model and interpret the estimated coefficients [Usage]
2. Conduct hypothesis tests and construct confidence intervals for regression parameters [Usage]
3. Verify the Gauss-Markov assumptions and assess their consequences when violated [Assessment]

Appendix C

Body of knowledge of Urbanism

The 10 knowledge areas in Urbanism are:

C.1 Foundations of the City and Urbanization (UFD) (Pg.. 304)
- C.1.1 The City, Urbanization, and Urban Systems (Pg.. 304)
- C.1.2 History and Theories of Urbanism (Pg.. 305)
- C.1.3 Urbanization in Latin America (Pg.. 305)
- C.1.4 Peruvian and Andean Urbanism (Pg.. 306)
- C.1.5 Urban Form and Morphology (Pg.. 306)
- C.1.6 Culture, Identity, and Urban Landscape (Pg.. 306)
- C.1.7 Informality and the Social Production of the City (Pg.. 307)
- C.1.8 Contemporary Theories and Urban Futures (Pg.. 307)

C.2 Territorial Analysis and Urban Information Systems (TAN) (Pg.. 308)
- C.2.1 Territorial Concepts, Scales, and Spatial Reference (Pg.. 308)
- C.2.2 Cartography and Spatial Representation (Pg.. 309)
- C.2.3 Geographic Information Systems (Pg.. 309)
- C.2.4 Remote Sensing and Earth Observation (Pg.. 310)
- C.2.5 Census, Cadastral, and Urban Data Sources (Pg.. 310)
- C.2.6 Spatial Analysis, Networks, and Accessibility (Pg.. 311)
- C.2.7 Urban Indicators, Diagnostics, and Visualization (Pg.. 311)
- C.2.8 Data Quality, Uncertainty, Privacy, and Ethics (Pg.. 311)

C.3 Urban Planning and Territorial Ordering (PLN) (Pg.. 312)
- C.3.1 Fundamentals and Methods of Planning (Pg.. 312)
- C.3.2 Territorial and Regional Planning (Pg.. 313)
- C.3.3 Metropolitan Planning and Interjurisdictional Governance (Pg.. 313)
- C.3.4 Urban Plans, Zoning, and Land-Use Regulation (Pg.. 314)
- C.3.5 Scenarios, Foresight, and Growth Management (Pg.. 314)
- C.3.6 Land Management and Value Capture (Pg.. 314)
- C.3.7 Implementation Instruments and Urban Management (Pg.. 315)
- C.3.8 Monitoring, Evaluation, and Plan Review (Pg.. 315)

C.4 Urban Design, Public Space, and Landscape (UDS) (Pg.. 316)
- C.4.1 Urban Design and Spatial Structure (Pg.. 316)
- C.4.2 Streets, Blocks, and Urban Grid (Pg.. 316)
- C.4.3 Public Space, Plazas, and Parks (Pg.. 317)
- C.4.4 Walkability, Road Safety, and Active Mobility (Pg.. 317)
- C.4.5 Neighborhood-Scale Design and Proximity (Pg.. 317)
- C.4.6 Urban Landscape, Street Trees, and Green Infrastructure (Pg.. 318)
- C.4.7 Universal Design, Accessibility, and Urban Experience (Pg.. 318)
- C.4.8 Urban Project, Representation, and Evaluation Criteria (Pg.. 319)

C.5 Housing, Habitat, and Social Inclusion (HSG) (Pg.. 319)
- C.5.1 Housing Systems and Typologies (Pg.. 319)
- C.5.2 Housing Policy and Affordability (Pg.. 320)
- C.5.3 Popular Habitat, Self-Building, and Incremental Housing (Pg.. 320)
- C.5.4 Comprehensive Neighborhood Upgrading (Pg.. 320)
- C.5.5 Tenure, Land, and Regularization (Pg.. 321)
- C.5.6 Segregation, Gentrification, and Displacement (Pg.. 321)
- C.5.7 Participation, Co-production, and the Right to the City (Pg.. 322)
- C.5.8 Gender, Care, and Groups in Situations of Vulnerability (Pg.. 322)

C.6 Urban Mobility and Transport (MOB) (Pg.. 322)
- C.6.1 Mobility Systems and Transport Demand (Pg.. 323)
- C.6.2 Public Transport and Intermodal Networks (Pg.. 323)
- C.6.3 Pedestrian and Cycling Mobility (Pg.. 324)
- C.6.4 Design and Management of Streets (Pg.. 324)
- C.6.5 Integrated Land Use and Transport (Pg.. 324)
- C.6.6 Accessibility and Equity in Mobility (Pg.. 325)
- C.6.7 Urban Logistics and Freight Transport (Pg.. 325)
- C.6.8 Road Safety, Emissions, and Mobility Evaluation (Pg.. 325)

C.7 Infrastructure, Services, and Urban Systems (INF) (Pg.. 326)
- C.7.1 Water, Sanitation, and Urban Drainage Networks (Pg.. 326)
- C.7.2 Energy and Utility Networks (Pg.. 327)
- C.7.3 Waste and Urban Circular Economy (Pg.. 327)
- C.7.4 Transport Infrastructure and Connectivity (Pg.. 327)
- C.7.5 Urban Facilities and Services (Pg.. 328)
- C.7.6 Blue-Green Infrastructure and Nature-Based Solutions (Pg.. 328)
- C.7.7 Coordination of Networks and Urban Asset Management (Pg.. 329)
- C.7.8 Financing, Operation, and Maintenance of Infrastructure (Pg.. 329)

C.8 Environment, Climate, and Urban Resilience (RES) (Pg.. 329)
- C.8.1 Urban Ecology and City Metabolism (Pg.. 330)
- C.8.2 Urban Climate, Heat Island, and Outdoor Comfort (Pg.. 330)
- C.8.3 Climate Change: Mitigation and Adaptation (Pg.. 331)
- C.8.4 Natural Hazards and Disaster Risk Reduction (Pg.. 331)
- C.8.5 Urban Water, Watersheds, and Sustainable Drainage (Pg.. 331)
- C.8.6 Biodiversity, Ecological Connectivity, and Ecosystem Services (Pg.. 332)
- C.8.7 Environmental Health, Pollution, and Exposure (Pg.. 332)
- C.8.8 Resilience, Recovery, and Emergency Planning (Pg.. 333)

C.9 Economy, Governance, and Urban Management (GOV)

(Pg.. 333)
- C.9.1 Urban Economy and Location (Pg.. 333)
- C.9.2 Land Economy and Real Estate Markets (Pg.. 334)
- C.9.3 Municipal Finance and Urban Budget (Pg.. 334)
- C.9.4 Institutions, Competencies, and Multilevel Governance (Pg.. 335)
- C.9.5 Urban Law and Regulatory Frameworks (Pg.. 335)
- C.9.6 Urban Project and Program Management (Pg.. 335)
- C.9.7 Public-Private Partnerships and Community Participation (Pg.. 336)
- C.9.8 Public Ethics, Transparency, and Accountability (Pg.. 336)

C.10 Research Methods, Technologies, and Professional Practice (TEC) (Pg.. 337)
- C.10.1 Qualitative Methods and Fieldwork (Pg.. 337)
- C.10.2 Quantitative Methods and Statistical Analysis (Pg.. 337)
- C.10.3 Participatory Research and Mixed Methods (Pg.. 338)
- C.10.4 Digital Twins and Three-Dimensional Urban Models (Pg.. 338)
- C.10.5 Sensors, Urban Data, and Civic Technology (Pg.. 339)
- C.10.6 Artificial Intelligence and Urban Analytics (Pg.. 339)
- C.10.7 Evaluation of Policies and Urban Impact (Pg.. 339)
- C.10.8 Communication, Interdisciplinary Collaboration, and Professional Practice (Pg.. 340)

C.1 Foundations of the City and Urbanization (UFD)

Conceptual and historical foundations for understanding cities, urbanization, urban form, culture, informality, and contemporary urban futures, with attention to Latin American, Andean, and Peruvian contexts.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.1.1 The City, Urbanization, and Urban Systems (Pg.. 304)	1	1
⭐ C.1.2 History and Theories of Urbanism (Pg.. 305)	1	1
⭐ C.1.3 Urbanization in Latin America (Pg.. 305)	1	1
⭐ C.1.4 Peruvian and Andean Urbanism (Pg.. 306)	1	1
⭐ C.1.5 Urban Form and Morphology (Pg.. 306)	1	1
⭐ C.1.6 Culture, Identity, and Urban Landscape (Pg.. 306)	1	1
⭐ C.1.7 Informality and the Social Production of the City (Pg.. 307)	1	1
⭐ C.1.8 Contemporary Theories and Urban Futures (Pg.. 307)	1	1

Table C.1: List of KUs in the Foundations of the City and Urbanization area.

C.1.1 UFD/The City, Urbanization, and Urban Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

The city as an object of study and urbanization as a global process; definitions, demographic and spatial transitions, urban subsystems, and actors shaping urban space.

Topics:

Core

- Statistical, morphological, functional, and sociological definitions of cities; the urban-rural continuum and intermediate settlements
- Urbanization, demographic transition, agglomeration, migration, and relationships between urbanization, industrialization, and development
- The city as an interrelated physical, social, economic, and environmental system; flows of people, goods, energy, water, and information
- Global urban population trends, megacities, intermediate cities, urbanization in the Global South, and demographic change
- Density, diversity, anonymity, and tolerance as dimensions of urban life and social organization
- Households, firms, governments, developers, communities, and civil society as actors producing urban space

Learning Outcomes:

Core:

1. Define city, urbanization, and urban system, and describe major features of the contemporary urban transition [Familiarity]
2. Analyze a city as a system of interrelated physical, social, economic, and environmental subsystems [Usage]

3. Evaluate urbanization's effects on society and the environment, identifying opportunities and challenges at different scales [Assessment]

C.1.2 UFD/History and Theories of Urbanism (Core Tier1: 1 hr, Core Tier2: 1 hr)

Historical evolution of cities and planning ideas, from ancient urban settlements to contemporary strategic and collaborative planning.

Topics:

Core

- Ancient, medieval, Renaissance, industrial, and post-industrial cities and their physical, social, and economic transformations
- Sanitary reform, City Beautiful, Garden City, linear city, and early twentieth-century planning ideals
- CIAM, functional zoning, comprehensive master planning, and postwar modernist urbanism
- Team 10, Jane Jacobs, mixed use, short blocks, and critiques of modernist planning
- Lefebvre's production of space and right to the city, Harvey's urban political economy, and Sennett's open city
- Anglo-American and Latin American planning traditions, New Urbanism, smart growth, and sustainable urbanism

Learning Outcomes:

Core:

1. Describe major eras in city history and explain their influence on contemporary urban form and institutions [Familiarity]
2. Apply historical urban theories to interpret a contemporary urban condition or inform a planning approach [Usage]
3. Critically evaluate planning traditions for their assumptions, achievements, limitations, and relevance to contemporary contexts [Assessment]

C.1.3 UFD/Urbanization in Latin America (Core Tier1: 1 hr, Core Tier2: 1 hr)

Distinctive patterns of Latin American urbanization, metropolitan primacy, informality, spatial segregation, and regional planning traditions.

Topics:

Core

- Rural-urban migration, early urbanization, metropolitanization, and demographic transition in Latin America
- Peripheral settlements, informal housing markets, and informal economies as components of Latin American urban development
- Socio-spatial polarization, gated communities, and unequal distribution of services, opportunities, and environmental quality
- Regional housing policy, neighborhood upgrading, social housing, and participatory planning traditions
- Growth management, climate vulnerability, public transport reform, and the right-to-the-city agenda
- Differences among Latin American metropolitan areas, intermediate cities, and small urban settlements

Learning Outcomes:

Core:

1. Identify distinctive features of Latin American urbanization and contrast them with patterns in other world regions [Familiarity]
2. Analyze a Latin American city using concepts of informality, segregation, primacy, and planning tradition [Usage]
3. Evaluate an urban policy in its Latin American context, considering inequality, informality, and institutional capacity [Assessment]

C.1.4 UFD/Peruvian and Andean Urbanism (Core Tier1: 1 hr, Core Tier2: 1 hr)

Evolution of Peruvian cities, urban planning institutions, territorial structures, and context-specific challenges of informality, risk, and heritage in Peru and the Andes.

Topics:

Core

- Pre-Hispanic and colonial foundations, republican growth, internal migration, metropolitan Lima, and the contemporary Peruvian urban system
- Urban planning roles of national and municipal institutions, municipal competencies, and the legal framework governing urban development and land subdivision
- Metropolitan Lima-Callao, regional urban networks, intermediate cities, and urban-rural interfaces in the Andes and Amazonia
- Informal settlement, tenure, seismic and landslide exposure, and risk-sensitive urban planning in Peru
- Historic urban centers, cultural landscapes, heritage conservation, and pressures of contemporary urban change
- Andean intermediate cities, city-countryside relations, regional markets, and territorial planning in mountain environments

Learning Outcomes:

Core:

1. Identify key periods in Peruvian urban history and describe the institutional framework of urban planning [Familiarity]
2. Analyze a Peruvian urban context in terms of urban form, institutions, informality, heritage, and risk [Usage]
3. Evaluate a Peruvian urban plan for institutional feasibility and responsiveness to local territorial conditions [Assessment]

C.1.5 UFD/Urban Form and Morphology (Core Tier1: 1 hr, Core Tier2: 1 hr)

Study of streets, blocks, plots, buildings, and open spaces; methods for describing urban tissues and relating form to city experience and performance.

Topics:

Core

- Streets, blocks, plots, buildings, and open spaces as interrelated components of urban form
- Conzenian analysis, figure-ground studies, typo-morphology, and space syntax for reading urban form
- Building, block, and street-pattern typologies, their variation, persistence, and transformation over time
- Lynch's paths, edges, districts, nodes, and landmarks and their role in wayfinding and urban identity
- Effects of urban form on accessibility, walkability, sunlight, land efficiency, and microclimate
- Consolidation, densification, subdivision, and regeneration as processes transforming urban neighborhoods

Learning Outcomes:

Core:

1. Identify principal morphological elements of a city and explain their relationships [Familiarity]
2. Use figure-ground, typo-morphology, or space-syntax methods to characterize an urban sector [Usage]
3. Evaluate the coherence, permeability, and adaptability of an urban area or design [Assessment]

C.1.6 UFD/Culture, Identity, and Urban Landscape (Core Tier1: 1 hr, Core Tier2: 1 hr)

Cultural and symbolic dimensions of cities, including place identity, collective memory, heritage, cultural diversity, and culture-led urban change.

Topics:

Core

- Place identity, attachment, belonging, memory, and the construction of meaning in urban environments
- Monuments, civic spaces, urban rituals, symbols, and the political contestation of public meaning

- Historic centers, cultural landscapes, intangible heritage, and memory in urban transformation
- Cultural districts, creative industries, flagship projects, and festivals as instruments of urban development
- Multicultural urban life, ethnic neighborhoods, integration, coexistence, and spatial expressions of difference
- Cultural change, tourism, commodification, and displacement associated with regeneration and gentrification

Learning Outcomes:

Core:

1. Describe cultural and symbolic dimensions of urban environments and how people attach meaning to places [Familiarity]
2. Analyze an urban place for identity, symbolic content, heritage value, and role in collective memory [Usage]
3. Evaluate an urban proposal for its treatment of cultural identity, heritage, and local meaning [Assessment]

C.1.7 UFD/Informality and the Social Production of the City (Core Tier1: 1 hr, Core Tier2: 1 hr)

Informality as a central urbanization process, including settlements, self-building, incremental housing, informal economies, and community production of habitat.

Topics:

Core

- Informal settlements, self-built housing, incremental consolidation, insecure tenure, and delayed provision of services
- Progressive housing development, technical assistance, enabling policies, and resident-led improvement
- Social production of habitat through cooperatives, mutual aid, community organizations, and civil society
- Street commerce, home-based enterprises, and informal work and their implications for urban space and regulation
- Informal land subdivision, occupation, rental, tenure insecurity, regularization, and associated political economy
- In-situ upgrading, regularization, relocation, prevention, and the risks of displacement

Learning Outcomes:

Core:

1. Define urban informality and describe common characteristics of informal settlements and urban production [Familiarity]
2. Analyze the physical, social, and economic dimensions of an informal settlement or self-building process [Usage]
3. Evaluate policy responses to informality for their effects on tenure security, wellbeing, and urban integration [Assessment]

C.1.8 UFD/Contemporary Theories and Urban Futures (Core Tier1: 1 hr, Core Tier2: 1 hr)

Contemporary frameworks for urbanism, including sustainability, smart and resilient cities, post-growth debates, and methods for exploring possible urban futures.

Topics:

Core

- Sustainable Development Goals, New Urban Agenda, and climate agendas as frameworks for urban policy and planning

- Smart, connected, and eco-city concepts, their planning applications, limitations, and critiques
- Post-growth and degrowth urbanism, sufficiency, circularity, and critiques of growth-dependent development
- Urban foresight methods: scenario planning, backcasting, horizon scanning, and exploration of alternative futures
- Digitalization, artificial intelligence, platform urbanism, and future changes in work, mobility, and urban life
- Ethical questions of urban futures: inclusion, surveillance, data governance, algorithmic bias, and public accountability

Learning Outcomes:

Core:

1. Describe contemporary urban agendas and methods used to explore alternative futures for cities [Familiarity]
2. Develop contrasting scenarios for an urban area using explicit demographic, environmental, technological, and policy assumptions [Usage]
3. Evaluate an urban future scenario for plausibility, equity, sustainability, and transparent treatment of uncertainty [Assessment]

C.2 Territorial Analysis and Urban Information Systems (TAN)

Geographic concepts, data, and analytical methods to describe and evaluate territories and cities. This area covers spatial scales and reference systems, cartography, GIS, remote sensing, census and cadastral data, network analysis, indicators, visualization, data quality, uncertainty, privacy, and responsible urban data practice.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.2.1 Territorial Concepts, Scales, and Spatial Reference (Pg.. 308)	1	1
⭐ C.2.2 Cartography and Spatial Representation (Pg.. 309)	1	1
⭐ C.2.3 Geographic Information Systems (Pg.. 309)	1	1
⭐ C.2.4 Remote Sensing and Earth Observation (Pg.. 310)	1	1
⭐ C.2.5 Census, Cadastral, and Urban Data Sources (Pg.. 310)	1	1
⭐ C.2.6 Spatial Analysis, Networks, and Accessibility (Pg.. 311)	1	1
⭐ C.2.7 Urban Indicators, Diagnostics, and Visualization (Pg.. 311)	1	1
⭐ C.2.8 Data Quality, Uncertainty, Privacy, and Ethics (Pg.. 311)	1	1

Table C.2: List of KUs in the Territorial Analysis and Urban Information Systems area.

C.2.1 TAN/Territorial Concepts, Scales, and Spatial Reference (Core Tier1: 1 hr, Core Tier2: 1 hr)

Territory as a spatially organized system and geographic foundations for defining units, scales, boundaries, coordinate systems, and spatial relationships in urban studies.

Topics:

Core

- Territory, place, region, landscape, and spatial extent as concepts for urban and territorial analysis
- Parcel, block, neighborhood, municipality, metropolitan area, and region; scale effects and the modifiable areal unit problem
- Census tracts, municipal limits, watersheds, labor-market areas, and metropolitan functional regions
- Geographic coordinates, projected coordinate reference systems, datums, map projections, and units
- Adjacency, containment, distance, direction, topology, and their role in geographic analysis
- Scale, resolution, extent, positional accuracy, and temporal resolution and their effects on interpretation

Learning Outcomes:
Core:

1. Describe territorial units, analytical scales, boundaries, and coordinate systems used in urban analysis [Familiarity]
2. Select defensible spatial units and coordinate systems for an urban or territorial research question [Usage]
3. Evaluate how scale, boundary choice, resolution, and spatial reference affect an urban analysis [Assessment]

C.2.2 TAN/Cartography and Spatial Representation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Principles for representing geographic information through maps, including design, symbolization, classification, scale, uncertainty, and accessible communication.
Topics:
Core

- Map purpose, audience, extent, scale, projection, legend, title, sources, and orientation
- Visual variables for spatial data: location, size, shape, hue, value, texture, and orientation
- Quantitative map classification: equal interval, quantile, natural breaks, and implications for interpretation
- Choropleth, proportional symbol, dot density, flow, isarithmic, and bivariate maps and their suitable data types
- Communication of positional, attribute, temporal, and model uncertainty without misleading emphasis
- Legibility, color-vision accessibility, visual hierarchy, annotation, and public-facing map design

Learning Outcomes:
Core:

1. Identify cartographic choices that shape how urban data are represented and interpreted [Familiarity]
2. Produce a thematic map with an appropriate projection, classification, visual hierarchy, and source documentation [Usage]
3. Evaluate a map for accuracy, legibility, accessibility, and risk of misrepresenting spatial patterns [Assessment]

C.2.3 TAN/Geographic Information Systems (Core Tier1: 1 hr, Core Tier2: 1 hr)

GIS concepts and workflows for acquiring, managing, querying, analyzing, and communicating vector and raster geographic data in planning.
Topics:
Core

- Vector points, lines, polygons, raster grids, attributes, geometry, and topology
- Spatial databases, schemas, metadata, identifiers, coordinate systems, and geospatial layer management
- Attribute and spatial queries: selection, overlay, proximity, spatial join, and Boolean combinations
- Buffer, clip, dissolve, intersect, union, network analysis, raster reclassification, and zonal statistics
- Integration of census, parcel, land-use, transport, environment, and field-survey layers with differing scales and schemas
- Documented processing models, open formats, versioned inputs, quality checks, and reproducible outputs

Learning Outcomes:
Core:

1. Explain GIS data models and spatial queries used in urban analysis [Familiarity]
2. Implement a documented GIS workflow that integrates urban datasets and produces a planning-relevant output [Usage]

3. Validate a GIS analysis for coordinate alignment, topology, attribute integrity, and reproducibility [Assessment]

C.2.4 TAN/Remote Sensing and Earth Observation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Acquisition and interpretation of satellite, aerial, and other remotely sensed data to observe urban land cover, change, environmental conditions, and spatial growth.

Topics:

Core

- Satellite, aerial, and UAV platforms and their spatial, spectral, temporal, and radiometric resolution
- Spectral signatures, bands, color composites, texture, and contextual interpretation of urban features
- Supervised, unsupervised, and object-based land-cover classification; training data and accuracy assessment
- Urban expansion, densification, land-cover change, and temporal comparison of imagery
- Spectral indicators of vegetation, impervious surface, water, and surface temperature
- Cloud, shadow, mixed pixels, sensor differences, classification error, and limits of inferring social conditions from imagery

Learning Outcomes:

Core:

1. Describe remote-sensing data types and their uses and limitations for observing cities [Familiarity]
2. Classify an urban land-cover image and document training data, processing choices, and accuracy [Usage]
3. Evaluate a remote-sensing result for resolution, accuracy, comparability, and planning fitness [Assessment]

C.2.5 TAN/Census, Cadastral, and Urban Data Sources (Core Tier1: 1 hr, Core Tier2: 1 hr)

Principal urban information sources and processes for interpreting demographic, socioeconomic, cadastral, land-use, infrastructure, and administrative data.

Topics:

Core

- Population and housing censuses: enumeration units, indicators, comparability, disclosure control, and limitations
- Land and property cadastres: parcel geometry, use, tenure attributes, building footprints, and registration
- Municipal permits, public services, taxation, infrastructure inventories, and administrative coverage limitations
- Open geospatial data, volunteered information, OpenStreetMap, data portals, licenses, and provenance
- Household, establishment, and field-survey data; sampling frames, geocoding, observation, and secondary-data integration
- Harmonization of spatial units, classifications, identifiers, time periods, and definitions across sources

Learning Outcomes:

Core:

1. Identify census, cadastral, administrative, and open-data sources for an urban planning question [Familiarity]
2. Integrate multiple urban data sources while preserving provenance, definitions, spatial units, and temporal reference [Usage]
3. Assess data coverage, definitions, licensing, and biases before using evidence in planning [Assessment]

C.2.6 TAN/Spatial Analysis, Networks, and Accessibility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Quantitative spatial methods for identifying urban patterns, relationships, and accessibility, including spatial statistics, network analysis, and service-area measurement.

Topics:

Core

- Proximity, buffers, nearest-neighbor relations, and service areas around facilities and hazards
- Street-network representation, connectivity, centrality, shortest paths, distance, and routing
- Cumulative-opportunity, gravity, and network-based measures of access to jobs, services, transport, and parks
- Spatial density and clustering, including kernel density estimation and local concentration measures
- Global and local spatial autocorrelation, clusters, hot spots, Moran's I, and related statistics
- Distribution of accessibility and environmental burdens across demographic groups and neighborhoods

Learning Outcomes:

Core:

1. Explain network analysis, accessibility measurement, and spatial autocorrelation [Familiarity]
2. Calculate network-based access to an urban service and compare coverage across neighborhoods [Usage]
3. Interpret spatial-analysis results considering scale, assumptions, population denominators, and equity [Assessment]

C.2.7 TAN/Urban Indicators, Diagnostics, and Visualization (Core Tier1: 1 hr, Core Tier2: 1 hr)

Selection, construction, interpretation, and communication of urban indicators and diagnostic frameworks for describing city conditions and monitoring plans.

Topics:

Core

- Indicator construct, numerator, denominator, unit, population, spatial unit, reference period, disaggregation, and source
- Indicator frameworks for services, housing, mobility, environment, prosperity, resilience, and quality of life
- Normalization, weighting, aggregation, sensitivity, and interpretation of composite urban indices
- Baselines, benchmarks, targets, trends, cross-city comparison, and limits to comparability
- Maps, charts, dashboards, and data stories for technical teams and public audiences
- Disaggregation by income, age, gender, disability, tenure, and neighborhood to reveal unequal outcomes

Learning Outcomes:

Core:

1. Describe a well-specified urban indicator and limitations of composite indices [Familiarity]
2. Construct spatially explicit urban indicators for diagnosing a planning issue and monitoring an intervention [Usage]
3. Evaluate an urban indicator framework for validity, comparability, disaggregation, and clarity [Assessment]

C.2.8 TAN/Data Quality, Uncertainty, Privacy, and Ethics (Core Tier1: 1 hr, Core Tier2: 1 hr)

Quality assurance and responsible stewardship of urban data, including uncertainty, representativeness, privacy, consent, algorithmic bias, security, and community data rights.

Topics:

Core

- Positional accuracy, completeness, consistency, currency, validity, lineage, and fitness for purpose

- Spatial uncertainty, sampling error, model assumptions, propagation, and sensitivity analysis
- Bias in administrative, volunteered, sensor, mobile, and remotely sensed urban datasets
- Privacy, informed consent, anonymization, aggregation, re-identification risk, and responsible release of location data
- Bias and fairness in geospatial models, automated classification, urban prediction, and resource allocation
- Data stewardship, CARE principles, Indigenous data sovereignty, community control, and equitable benefit

Learning Outcomes:

Core:

1. Identify sources of bias, uncertainty, privacy risk, and quality defects in urban data [Familiarity]
2. Document limitations, uncertainty, privacy safeguards, and provenance for an urban spatial analysis [Usage]
3. Evaluate an urban data project for representativeness, consent, re-identification risk, and distributional impacts [Assessment]

C.3 Urban Planning and Territorial Ordering (PLN)

Theories, methods, and instruments for planning cities and territories, from plan-making fundamentals through metropolitan governance, zoning, land management, implementation, and monitoring.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.3.1 Fundamentals and Methods of Planning (Pg.. 312)	1	1
⭐ C.3.2 Territorial and Regional Planning (Pg.. 313)	1	1
⭐ C.3.3 Metropolitan Planning and Interjurisdictional Governance (Pg.. 313)	1	1
⭐ C.3.4 Urban Plans, Zoning, and Land-Use Regulation (Pg.. 314)	1	1
⭐ C.3.5 Scenarios, Foresight, and Growth Management (Pg.. 314)	1	1
⭐ C.3.6 Land Management and Value Capture (Pg.. 314)	1	1
⭐ C.3.7 Implementation Instruments and Urban Management (Pg.. 315)	1	1
⭐ C.3.8 Monitoring, Evaluation, and Plan Review (Pg.. 315)	1	1

Table C.3: List of KUs in the Urban Planning and Territorial Ordering area.

C.3.1 PLN/Fundamentals and Methods of Planning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Core concepts, rationales, and procedural models of urban and territorial planning, including the planning cycle, normative traditions, and the plan-making process.

Topics:

Core

- Market failures, externalities, collective goods, and coordination problems that justify public planning intervention
- Rational-comprehensive, incremental, advocacy, communicative, and strategic planning models
- Diagnosis, goal setting, alternatives, plan formulation, adoption, implementation, and review as a recurring cycle
- Comprehensive, strategic, structure, sectoral, and special-area plans and their relationships
- Diagnosis, baseline studies, projections, and use of evidence to justify planning proposals
- Public interest, professional responsibility, and ethical dilemmas in planning practice

Learning Outcomes:

Core:

1. Describe the rationale for public planning and the stages of the planning cycle [Familiarity]
2. Apply a planning-process model to structure a diagnosis-to-implementation study for an urban area [Usage]

3. Evaluate a planning process for its rationale, evidence base, and procedural legitimacy [Assessment]

C.3.2 PLN/Territorial and Regional Planning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning at regional and territorial scales, integrating urban systems, rural areas, natural resources, and infrastructure corridors across jurisdictions.

Topics:

Core

- Regional development frameworks, polycentric settlement systems, and urban-rural linkages
- Land-use zoning at territorial scale, resource protection areas, and territorial-ordering instruments
- Transport and infrastructure corridors, economic corridors, and their territorial development effects
- Integration of watersheds, agricultural land, protected areas, and hazard zones into territorial plans
- Coordination across administrative and international boundaries for shared territorial systems
- Peru's territorial-ordering instruments and their relationship to municipal and regional planning

Learning Outcomes:

Core:

1. Explain how territorial planning integrates urban systems, natural resources, and infrastructure across scales [Familiarity]
2. Analyze a regional territorial system for settlement pattern, resource constraints, and connectivity [Usage]
3. Evaluate a territorial plan for coherence across urban, rural, and environmental objectives [Assessment]

C.3.3 PLN/Metropolitan Planning and Interjurisdictional Governance (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning and governance challenges of metropolitan areas spanning multiple municipalities, including coordination mechanisms and metropolitan institutions.

Topics:

Core

- Jurisdictional fragmentation, spillovers, and coordination failures in metropolitan areas
- Metropolitan government, special districts, voluntary cooperation, and regional authorities as governance models
- Metropolitan structure plans, shared service provision, and cross-jurisdictional infrastructure planning
- Metropolitan fiscal disparities, tax-base sharing, and cost-sharing arrangements
- Subcenters, edge cities, and strategies for balanced metropolitan development
- Metropolitan governance of Lima-Callao as a case of interjurisdictional coordination

Learning Outcomes:

Core:

1. Describe governance models used to coordinate planning across metropolitan jurisdictions [Familiarity]
2. Analyze a metropolitan coordination problem and the institutional options available to address it [Usage]
3. Evaluate a metropolitan governance arrangement for effectiveness, legitimacy, and fiscal equity [Assessment]

C.3.4 PLN/Urban Plans, Zoning, and Land-Use Regulation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Instruments that regulate land use, density, and building form, including zoning ordinances, master plans, and alternative code-based approaches.

Topics:

Core

- Use, density, height, setback, and coverage controls as the core components of zoning ordinances
- Euclidean, performance, incentive, and form-based zoning approaches
- Land-use plans, urban development plans, and their legal relationship to zoning regulation
- Subdivision regulations, infrastructure standards, and conditions attached to development approval
- Variances, conditional uses, nonconforming uses, and administrative discretion in regulation
- Exclusionary effects, housing-supply constraints, and critiques of restrictive zoning

Learning Outcomes:

Core:

1. Explain the components and legal basis of zoning ordinances and land-use plans [Familiarity]
2. Apply a zoning or form-based code to evaluate whether a proposed development is compliant [Usage]
3. Evaluate a zoning regulation for its effects on housing supply, equity, and urban form outcomes [Assessment]

C.3.5 PLN/Scenarios, Foresight, and Growth Management (Core Tier1: 1 hr, Core Tier2: 1 hr)

Methods for anticipating urban growth and testing alternative development futures to inform plan-making and growth-management policy.

Topics:

Core

- Population and employment projections, allocation methods, and land-demand estimation
- Alternative-futures scenario building, trend versus normative scenarios, and scenario comparison
- Urban growth boundaries, phased development, and infrastructure-led growth management
- Infill, densification, and peripheral expansion as alternative growth strategies
- Land and infrastructure capacity analysis to test the feasibility of growth scenarios
- Visualization and communication of alternative futures to decision makers and the public

Learning Outcomes:

Core:

1. Describe methods for projecting urban growth and constructing alternative-future scenarios [Familiarity]
2. Develop and compare growth scenarios for an urban area under different policy assumptions [Usage]
3. Evaluate a growth-management strategy for its land, infrastructure, and equity implications [Assessment]

C.3.6 PLN/Land Management and Value Capture (Core Tier1: 1 hr, Core Tier2: 1 hr)

Instruments for managing urban land and capturing publicly generated increases in land value to finance infrastructure and urban development.

Topics:

Core

- Land rent, location value, and the relationship between public investment and land-value increments
- Betterment levies, development exactions, impact fees, and special assessment districts

- Land readjustment, land pooling, and consolidation mechanisms for serviced-land delivery
- Transfer of development rights and bonus-density mechanisms linked to public benefit
- Public land banking, land assembly, and strategic acquisition for planning purposes
- Latin American value-capture experience, including Colombia's participación en plusvalías and Brazil's outorga onerosa

Learning Outcomes:

Core:

1. Explain how public action generates land-value increments and the logic of value-capture instruments [Familiarity]
2. Design a value-capture instrument appropriate to a specific urban development or infrastructure project [Usage]
3. Evaluate a land-value-capture scheme for revenue potential, equity, and administrative feasibility [Assessment]

C.3.7 PLN/Implementation Instruments and Urban Management (Core Tier1: 1 hr, Core Tier2: 1 hr)

Legal, administrative, and financial instruments that translate plans into implemented urban development, and the institutions that manage them.

Topics:

Core

- Permits, licenses, development agreements, and other regulatory approval instruments
- Public investment programs, grants, municipal bonds, and dedicated urban development funds
- Development agreements, concessions, and joint ventures for implementing urban projects
- Urban renewal areas, special management zones, and improvement districts as implementation vehicles
- Planning-agency staffing, technical capacity, and inter-agency coordination required for implementation
- Phasing of infrastructure and development to align public investment with implementation capacity

Learning Outcomes:

Core:

1. Identify the regulatory, financial, and institutional instruments available to implement a plan [Familiarity]
2. Select an appropriate implementation instrument for a specific plan objective and institutional context [Usage]
3. Assess the institutional and financial feasibility of implementing a proposed plan [Assessment]

C.3.8 PLN/Monitoring, Evaluation, and Plan Review (Core Tier1: 1 hr, Core Tier2: 1 hr)

Methods for tracking plan implementation, measuring outcomes against objectives, and updating plans in response to changing conditions.

Topics:

Core

- Output, outcome, and impact indicators for tracking plan implementation over time
- Tracking approvals, investments, and development activity against plan targets
- Baseline, process, and outcome evaluation designs applied to urban and territorial plans
- Triggers, procedures, and governance of formal plan review and amendment
- Adaptive and rolling plan frameworks that respond to monitoring feedback and uncertainty
- Public reporting on plan performance and accountability mechanisms for planning authorities

Learning Outcomes:

Core:

1. Describe indicators and methods used to monitor implementation of an urban plan [Familiarity]
2. Design a monitoring framework with indicators, targets, and reporting cycles for a specific plan [Usage]

3. Evaluate plan performance against stated objectives and recommend revisions [Assessment]

C.4 Urban Design, Public Space, and Landscape (UDS)

Principles and practice of shaping the physical and experiential qualities of urban space, from street and block structure through public space, landscape, accessibility, and urban project evaluation.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.4.1 Urban Design and Spatial Structure (Pg.. 316)	1	1
⭐ C.4.2 Streets, Blocks, and Urban Grid (Pg.. 316)	1	1
⭐ C.4.3 Public Space, Plazas, and Parks (Pg.. 317)	1	1
⭐ C.4.4 Walkability, Road Safety, and Active Mobility (Pg.. 317)	1	1
⭐ C.4.5 Neighborhood-Scale Design and Proximity (Pg.. 317)	1	1
⭐ C.4.6 Urban Landscape, Street Trees, and Green Infrastructure (Pg.. 318)	1	1
⭐ C.4.7 Universal Design, Accessibility, and Urban Experience (Pg.. 318)	1	1
⭐ C.4.8 Urban Project, Representation, and Evaluation Criteria (Pg.. 319)	1	1

Table C.4: List of KUs in the Urban Design, Public Space, and Landscape area.

C.4.1 UDS/Urban Design and Spatial Structure (Core Tier1: 1 hr, Core Tier2: 1 hr)

Core principles, dimensions, and processes of urban design as the discipline shaping the public realm and the relationship between buildings and open space.

Topics:

Core

- Morphological, perceptual, social, visual, functional, and temporal dimensions of urban design
- Figure-ground relationships, enclosure, edge conditions, and definition of public space by building form
- Analysis, concept development, massing, and detailed urban-design processes at multiple scales
- Urban design guidelines, pattern books, and design-review frameworks
- Thresholds, frontages, setbacks, and the interface between private buildings and public space
- Relationship between urban design and statutory planning, zoning, and development control

Learning Outcomes:

Core:

1. Describe the dimensions of urban design and their relationship to the public realm [Familiarity]
2. Develop an urban-design concept for a site that defines spatial structure and public-private interfaces [Usage]
3. Evaluate an urban design proposal for coherence, enclosure, and quality of the public realm [Assessment]

C.4.2 UDS/Streets, Blocks, and Urban Grid (Core Tier1: 1 hr, Core Tier2: 1 hr)

Design and configuration of street networks and block structure as the organizing framework of urban form.

Topics:

Core

- Grid, radial, organic, and hierarchical street-network patterns and their performance tradeoffs
- Block size, permeability, and subdivision as determinants of walkability and development flexibility
- Functional classification of streets and its relationship to urban design character
- Street cross-section allocation among travel lanes, parking, sidewalks, and green infrastructure
- Intersection geometry, corner design, and its effects on safety and pedestrian experience
- Complete-streets principles balancing multiple users and modes within the right-of-way

Learning Outcomes:
Core:

1. Identify street-network patterns and explain their effects on connectivity and urban form [Familiarity]
2. Design a street and block layout for a new or infill urban area [Usage]
3. Evaluate a street network for connectivity, block size, and multimodal performance [Assessment]

C.4.3 UDS/Public Space, Plazas, and Parks (Core Tier1: 1 hr, Core Tier2: 1 hr)

Design, programming, and management of public open spaces, including plazas, parks, and informal public space, as settings for urban social life.
Topics:
Core

- Plazas, squares, parks, waterfronts, and informal public spaces and their characteristic uses
- Observation methods for how people use public space, sociability, triangulation, and sittable space
- Edges, seating, microclimate, and furnishing as determinants of successful public-space design
- Park systems, distribution standards, and hierarchy of open space provision
- Programming, activation, maintenance, and governance of public spaces over time
- Inclusion, safety, and equitable access to public space across social groups

Learning Outcomes:
Core:

1. Describe characteristics that make public spaces successful settings for social life [Familiarity]
2. Design a public space that responds to microclimate, edges, seating, and intended uses [Usage]
3. Evaluate a public space for use patterns, inclusivity, and management arrangements [Assessment]

C.4.4 UDS/Walkability, Road Safety, and Active Mobility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Design conditions that support safe, comfortable walking and cycling, including sidewalk design, crossings, and traffic-calming measures.
Topics:
Core

- Useful, safe, comfortable, and interesting conditions that make walking a viable choice
- Sidewalk width, clear path, furnishing zones, and continuity standards
- Crosswalk design, signal timing, curb extensions, and pedestrian priority at intersections
- Speed management, chicanes, narrowing, and other traffic-calming measures
- Bicycle lanes, cycle tracks, and network design to support everyday cycling
- Vision Zero and safe-systems approaches to eliminating traffic deaths and severe injuries

Learning Outcomes:
Core:

1. Explain design conditions that influence walking and cycling behavior and safety [Familiarity]
2. Redesign a street segment to improve pedestrian and cyclist safety and comfort [Usage]
3. Evaluate a street or intersection for walkability and traffic-safety performance [Assessment]

C.4.5 UDS/Neighborhood-Scale Design and Proximity (Core Tier1: 1 hr, Core Tier2: 1 hr)

Design of residential neighborhoods at a human scale, including proximity to daily needs, local identity, and the balance of density and livability.
Topics:
Core

- The neighborhood-unit concept, its assumptions, and its contemporary critiques and adaptations
- 15-minute city and similar proximity-based frameworks for daily needs accessibility

- Local identity, legibility, and distinctiveness at the neighborhood scale
- Density thresholds that support local services while preserving neighborhood livability
- Mixed-use neighborhood design integrating housing, commerce, and community facilities
- Schools, health posts, community centers, and other social infrastructure at the neighborhood scale

Learning Outcomes:
Core:

1. Describe proximity-based frameworks for neighborhood design and their service-distribution logic [Familiarity]
2. Apply a proximity framework to assess access to daily needs from a residential neighborhood [Usage]
3. Evaluate a neighborhood design for density, mix, identity, and social-infrastructure provision [Assessment]

C.4.6 UDS/Urban Landscape, Street Trees, and Green Infrastructure (Core Tier1: 1 hr, Core Tier2: 1 hr)

Design and management of vegetated and landscaped elements of the public realm, including street trees, green corridors, and urban forestry.
Topics:
Core

- Street trees, canopy cover, species selection, and urban forestry management
- Planting design, topography, and material selection in urban landscape projects
- Green corridors, linear parks, and ecological connectivity through the urban fabric
- Vegetation's effects on microclimate, shade, and thermal comfort in public space
- Irrigation, maintenance regimes, and long-term stewardship of urban landscapes
- Landscape strategies for arid and water-scarce urban contexts, including xeriscaping and fog-water use

Learning Outcomes:
Core:

1. Describe the roles of street trees, green corridors, and landscape in the public realm [Familiarity]
2. Design a street or public-space landscape plan appropriate to the local climate and water availability [Usage]
3. Evaluate an urban landscape design for ecological function, comfort, and maintainability [Assessment]

C.4.7 UDS/Universal Design, Accessibility, and Urban Experience (Core Tier1: 1 hr, Core Tier2: 1 hr)

Design principles and standards ensuring urban space is usable by people of all ages and abilities, and attention to the experiential quality of the city.
Topics:
Core

- Equitable use, flexibility, and the core principles of universal design applied to public space
- Ramps, tactile paving, curb cuts, and accessibility standards for sidewalks and public buildings
- Design considerations for children, older adults, and caregivers in public space
- Sensory, perceptual, and experiential qualities of urban environments
- Signage, tactile cues, and wayfinding systems accessible to diverse users
- Methods for auditing public space and infrastructure for accessibility compliance

Learning Outcomes:
Core:

1. Identify universal-design principles and accessibility standards applicable to public space [Familiarity]
2. Audit a public space or street for accessibility barriers and propose improvements [Usage]
3. Evaluate an urban design proposal for universal accessibility and inclusive experience [Assessment]

C.4.8 UDS/Urban Project, Representation, and Evaluation Criteria (Core Tier1: 1 hr, Core Tier2: 1 hr)

Development and communication of urban design proposals at the project scale, and criteria used to review and evaluate their quality.

Topics:

Core

- Site, block, and district-scale urban projects and their relationship to broader plans
- Plans, sections, perspectives, and diagrams used to communicate urban design proposals
- Criteria for design review: context fit, public-realm quality, and performance against guidelines
- Presenting urban design proposals to technical panels, officials, and community audiences
- Phasing an urban project across multiple stages of investment and construction
- Post-occupancy evaluation of urban projects against original design intentions

Learning Outcomes:

Core:

1. Describe representation techniques and review criteria used to evaluate urban design projects [Familiarity]
2. Develop and represent an urban project proposal at an appropriate scale and level of detail [Usage]
3. Evaluate an urban project against design-review criteria and stated planning objectives [Assessment]

C.5 Housing, Habitat, and Social Inclusion (HSG)

Housing systems, policy, and the social dimensions of habitat, including affordability, informal and incremental housing, neighborhood upgrading, tenure, displacement, participation, and inclusion.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.5.1 Housing Systems and Typologies (Pg.. 319)	1	1
⭐ C.5.2 Housing Policy and Affordability (Pg.. 320)	1	1
⭐ C.5.3 Popular Habitat, Self-Building, and Incremental Housing (Pg.. 320)	1	1
⭐ C.5.4 Comprehensive Neighborhood Upgrading (Pg.. 320)	1	1
⭐ C.5.5 Tenure, Land, and Regularization (Pg.. 321)	1	1
⭐ C.5.6 Segregation, Gentrification, and Displacement (Pg.. 321)	1	1
⭐ C.5.7 Participation, Co-production, and the Right to the City (Pg.. 322)	1	1
⭐ C.5.8 Gender, Care, and Groups in Situations of Vulnerability (Pg.. 322)	1	1

Table C.5: List of KUs in the Housing, Habitat, and Social Inclusion area.

C.5.1 HSG/Housing Systems and Typologies (Core Tier1: 1 hr, Core Tier2: 1 hr)

Classification of housing types and delivery systems, and how dwelling form relates to density, tenure, and urban structure.

Topics:

Core

- Single-family, row-house, walk-up, and tower typologies and their density and land-use implications
- Public, private, cooperative, and self-built housing-delivery systems
- Support and infill, adaptable structure, and open-building approaches to housing flexibility
- Relationships between dwelling typology, density, and land consumption
- Minimum habitability, space, ventilation, and sanitation standards for housing
- Condominium regimes, shared ownership, and management of multifamily housing

Learning Outcomes:

Core:

1. Classify housing types by typology, density, and delivery system [Familiarity]

2. Compare housing typologies for suitability to a given density target and household profile [Usage]
3. Evaluate a housing typology against habitability standards and long-term adaptability [Assessment]

C.5.2 HSG/Housing Policy and Affordability (Core Tier1: 1 hr, Core Tier2: 1 hr)

Public policy instruments addressing housing affordability, supply, and the relationship between housing markets and household welfare.

Topics:

Core

- Housing cost burden, affordability ratios, and measurement of housing affordability
- Zoning reform, density bonuses, and supply-side policies to expand housing production
- Housing subsidies, vouchers, and mortgage-support programs as demand-side instruments
- Public housing, social rental housing, and inclusionary housing models
- Peru's housing programs, including Techo Propio and Mi Vivienda, and their design and outcomes
- Mortgage markets, housing finance institutions, and access to housing credit

Learning Outcomes:

Core:

1. Describe measures of housing affordability and the main categories of housing policy instruments [Familiarity]
2. Analyze a housing-affordability problem and identify policy instruments that could address it [Usage]
3. Evaluate a housing program for its effects on affordability, supply, and targeting [Assessment]

C.5.3 HSG/Popular Habitat, Self-Building, and Incremental Housing (Core Tier1: 1 hr, Core Tier2: 1 hr)

Processes through which low-income households produce and progressively improve their own housing, and policies that support or constrain this production.

Topics:

Core

- Stages of self-building: occupation, consolidation, and progressive improvement of the dwelling
- Sites-and-services and core-housing approaches that support incremental construction
- Technical assistance, construction guidance, and building-material support for self-builders
- Microfinance and incremental financing mechanisms suited to progressive housing
- Household investment patterns, labor, and the economics of progressive home improvement
- Structural and seismic risk associated with unassisted incremental construction

Learning Outcomes:

Core:

1. Describe the stages and logic of self-built, incremental housing production [Familiarity]
2. Design a technical-assistance or sites-and-services program to support incremental housing [Usage]
3. Evaluate a popular-habitat program for its effects on housing quality, cost, and structural safety [Assessment]

C.5.4 HSG/Comprehensive Neighborhood Upgrading (Core Tier1: 1 hr, Core Tier2: 1 hr)

Integrated approaches to improving infrastructure, services, housing, and tenure in existing low-income and informal neighborhoods.

Topics:

Core

- In-situ upgrading principles: minimal displacement, incremental investment, and community engagement

- Extension of water, sanitation, drainage, electricity, and paved access in consolidated informal areas
- Structural reinforcement, roofing, and incremental housing-quality improvement within upgrading programs
- Institutional arrangements, financing, and multi-sector coordination for upgrading programs
- Participatory diagnosis, priority setting, and community oversight in upgrading projects
- Monitoring and evaluating upgrading programs for coverage, quality, and sustainability

Learning Outcomes:

Core:

1. Explain the principles and components of comprehensive neighborhood upgrading [Familiarity]
2. Design an integrated upgrading intervention for a specific informal settlement [Usage]
3. Evaluate an upgrading program for coverage, participation, and durability of outcomes [Assessment]

C.5.5 HSG/Tenure, Land, and Regularization (Core Tier1: 1 hr, Core Tier2: 1 hr)

Forms of land and housing tenure, insecurity of tenure in informal settlements, and processes for formalizing land rights.

Topics:

Core

- Ownership, leasehold, rental, communal, and customary tenure arrangements
- Sources of tenure insecurity in informal settlements and their effects on investment and wellbeing
- Titling, cadastral survey, and legal procedures for land and property regularization
- Community land trusts and other alternative tenure models that balance security and affordability
- Limits of titling alone to improve welfare, and risks of regularization without complementary services
- Peru's institutional framework for informal settlement formalization, including COFOPRI and municipal procedures

Learning Outcomes:

Core:

1. Describe tenure types and the main sources of tenure insecurity in informal settlements [Familiarity]
2. Analyze the regularization needs and options for a specific informal settlement [Usage]
3. Evaluate a land-regularization program for its effectiveness and complementary service provision [Assessment]

C.5.6 HSG/Segregation, Gentrification, and Displacement (Core Tier1: 1 hr, Core Tier2: 1 hr)

Processes of residential segregation, neighborhood change, and displacement, and their relationship to housing markets and urban policy.

Topics:

Core

- Measures and patterns of residential segregation by income, ethnicity, and other social attributes
- Market, policy, and discriminatory mechanisms that produce and reproduce segregation
- Stages, drivers, and indicators of gentrification in changing neighborhoods
- Direct, exclusionary, and cultural displacement and methods for identifying displacement risk
- Rent regulation, right-to-return, and anti-displacement policy instruments
- Equitable transit-oriented and infill development strategies that limit displacement risk

Learning Outcomes:

Core:

1. Explain how residential segregation and gentrification arise and are measured [Familiarity]
2. Assess displacement risk in a neighborhood undergoing investment or regulatory change [Usage]

3. Evaluate anti-displacement and equitable-development policies for a changing neighborhood [Assessment]

C.5.7 HSG/Participation, Co-production, and the Right to the City (Core Tier1: 1 hr, Core Tier2: 1 hr)

Frameworks and methods for community participation in housing and habitat decisions, and the conceptual foundations of the right to the city.

Topics:

Core

- Degrees of participation from information to citizen control, and their application to housing and habitat projects
- Co-production of housing and services between communities, the state, and other actors
- The right to the city as a framework linking urban space, inhabitance, and collective decision-making
- Workshops, participatory mapping, and deliberative methods used in housing and habitat planning
- Housing cooperatives, neighborhood associations, and community organizations as participation vehicles
- Power asymmetries, tokenism, and limits of participatory processes in practice

Learning Outcomes:

Core:

1. Describe frameworks for assessing the degree and quality of community participation [Familiarity]
2. Design a participatory process appropriate to a specific housing or habitat decision [Usage]
3. Evaluate a participatory process for genuine influence on housing and habitat outcomes [Assessment]

C.5.8 HSG/Gender, Care, and Groups in Situations of Vulnerability (Core Tier1: 1 hr, Core Tier2: 1 hr)

Gender and intersectional dimensions of housing and habitat, including caregiving, safety, and the needs of groups in situations of vulnerability.

Topics:

Core

- How gender roles shape housing location, size, and design needs
- Care work, proximity to services, and spatial implications of the care economy
- Urban design and planning responses to gender-based violence and perceived safety
- Housing and habitat needs of older adults, people with disabilities, and other groups in situations of vulnerability
- Intersectional analysis of housing access combining gender, income, ethnicity, and disability
- Housing and habitat policy instruments that explicitly target gender and vulnerability gaps

Learning Outcomes:

Core:

1. Identify gender and vulnerability dimensions relevant to housing and habitat conditions [Familiarity]
2. Analyze a neighborhood or housing project for gender and intersectional safety and access considerations [Usage]
3. Evaluate a housing or habitat policy for its responsiveness to gender and vulnerable-group needs [Assessment]

C.6 Urban Mobility and Transport (MOB)

Planning, design, and management of urban mobility systems, integrating public transport, active modes, street design, land use, equity, freight, and safety.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.6.1 Mobility Systems and Transport Demand (Pg.. 323)	1	1
⭐ C.6.2 Public Transport and Intermodal Networks (Pg.. 323)	1	1
⭐ C.6.3 Pedestrian and Cycling Mobility (Pg.. 324)	1	1
⭐ C.6.4 Design and Management of Streets (Pg.. 324)	1	1
⭐ C.6.5 Integrated Land Use and Transport (Pg.. 324)	1	1
⭐ C.6.6 Accessibility and Equity in Mobility (Pg.. 325)	1	1
⭐ C.6.7 Urban Logistics and Freight Transport (Pg.. 325)	1	1
⭐ C.6.8 Road Safety, Emissions, and Mobility Evaluation (Pg.. 325)	1	1

Table C.6: List of KUs in the Urban Mobility and Transport area.

C.6.1 MOB/Mobility Systems and Transport Demand (Core Tier1: 1 hr, Core Tier2: 1 hr)

Structure of urban mobility systems and fundamental methods for understanding and forecasting travel demand.

Topics:

Core

- Modes, networks, infrastructure, and institutions comprising an urban mobility system
- Trip generation, distribution, mode choice, and the factors driving urban travel demand
- The conventional four-step travel-demand modeling framework and its application and limitations
- Measurement and interpretation of modal share and its drivers across cities
- Household travel surveys and other data sources used to characterize urban mobility
- Ride-hailing, micromobility, and other emerging mobility services reshaping travel demand

Learning Outcomes:

Core:

1. Describe the components of an urban mobility system and determinants of travel demand [Familiarity]
2. Analyze travel-survey or mobility data to characterize demand patterns in an urban area [Usage]
3. Evaluate a travel-demand forecast for its assumptions, data quality, and planning implications [Assessment]

C.6.2 MOB/Public Transport and Intermodal Networks (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning, operation, and integration of public transport modes and networks as the backbone of sustainable urban mobility.

Topics:

Core

- Bus, bus rapid transit, light rail, metro, and other public transport modes and their performance characteristics
- Route design, service frequency, coverage, and network-structure tradeoffs
- Fare, schedule, and physical integration across public transport modes and with active modes
- Scheduling, fleet management, and operational planning for public transport service
- Fare policy, subsidies, and financing models for public transport systems
- Peruvian public transport systems, including Lima's Metropolitano and Metro de Lima, and their planning context

Learning Outcomes:

Core:

1. Explain the characteristics and tradeoffs of different public transport modes [Familiarity]
2. Design a public transport route or network segment to serve a specified demand corridor [Usage]
3. Evaluate a public transport network for coverage, integration, and financial sustainability [Assessment]

C.6.3 MOB/Pedestrian and Cycling Mobility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning and network design for walking and cycling as primary modes of urban mobility, distinct from their street-level design treatment.

Topics:

Core

- Measurement and comparative analysis of walking and cycling mode share across cities
- Pedestrian network planning, desire lines, and gap analysis at the city scale
- Cycling network planning, connectivity, and levels of traffic stress
- Bike-share and micromobility system planning and integration with the broader network
- Policies and programs that encourage walking and cycling as everyday travel choices
- Topographic, climatic, safety, and cultural barriers to walking and cycling adoption

Learning Outcomes:

Core:

1. Describe methods for planning citywide pedestrian and cycling networks [Familiarity]
2. Plan a citywide cycling network addressing connectivity gaps and levels of traffic stress [Usage]
3. Evaluate a city's active-mobility network for coverage, connectivity, and mode-share outcomes [Assessment]

C.6.4 MOB/Design and Management of Streets (Core Tier1: 1 hr, Core Tier2: 1 hr)

Allocation and management of street space among competing users, and operational strategies for managing traffic and curb activity.

Topics:

Core

- Allocating right-of-way among travel lanes, transit, parking, and active modes based on street function
- Curb-space management for parking, loading, transit stops, and competing demands
- Signal timing, one-way systems, and traffic-management strategies for urban streets
- On-street and off-street parking policy, pricing, and minimum or maximum parking requirements
- Tactical urbanism and pilot interventions for testing street redesigns before permanent investment
- Metrics for evaluating street performance across modes rather than vehicle throughput alone

Learning Outcomes:

Core:

1. Explain principles for allocating and managing street space among competing uses [Familiarity]
2. Redesign the space allocation of an urban street to better balance multimodal demand [Usage]
3. Evaluate a street-management scheme for its effects on safety, access, and curb efficiency [Assessment]

C.6.5 MOB/Integrated Land Use and Transport (Core Tier1: 1 hr, Core Tier2: 1 hr)

Reciprocal relationships between land use and transport, and planning approaches that integrate the two to shape travel behavior.

Topics:

Core

- Feedback loops between accessibility, land development, and travel demand
- Density, diversity, and design as built-environment factors influencing travel behavior
- Transit-oriented development principles, station-area planning, and density gradients around transit
- Coordinated planning of transport corridors and the land uses they serve
- Parking requirements' effects on density, land consumption, and development feasibility
- Planning oriented toward accessibility to opportunities rather than vehicle mobility alone

Learning Outcomes:
Core:
1. Explain the feedback relationship between land use and transport demand [Familiarity]
2. Develop a transit-oriented development concept for a station area [Usage]
3. Evaluate a land-use and transport plan for internal consistency and accessibility outcomes [Assessment]

C.6.6 MOB/Accessibility and Equity in Mobility (Core Tier1: 1 hr, Core Tier2: 1 hr)

Distribution of mobility benefits and burdens across population groups, and planning approaches that advance mobility equity.
Topics:
Core
- Horizontal and vertical equity concepts applied to transport planning and investment
- Transport disadvantage, captive ridership, and populations with constrained mobility options
- Methods for analyzing accessibility distribution across income, gender, and disability groups
- Fare affordability, subsidized fare programs, and their effects on low-income ridership
- Equity analysis of transport capital-investment decisions across neighborhoods
- Participatory methods for incorporating equity concerns into transport planning decisions

Learning Outcomes:
Core:
1. Describe concepts and measures of equity applied to urban mobility [Familiarity]
2. Analyze accessibility distribution across neighborhoods to identify mobility-equity gaps [Usage]
3. Evaluate a transport investment program for its equity implications across population groups [Assessment]

C.6.7 MOB/Urban Logistics and Freight Transport (Core Tier1: 1 hr, Core Tier2: 1 hr)

Movement of goods within cities, including last-mile delivery, freight infrastructure, and conflicts between freight and other urban mobility functions.
Topics:
Core
- Freight trip generation, delivery patterns, and the structure of urban goods movement
- Last-mile delivery models, including e-commerce growth and its effects on urban streets
- Loading zones, distribution centers, and freight-dedicated infrastructure in cities
- Delivery-time windows, vehicle-size restrictions, and other freight-regulation tools
- Urban consolidation centers and micro-logistics hubs to reduce freight trips
- Conflicts between freight operations and pedestrian, cyclist, and transit priorities

Learning Outcomes:
Core:
1. Explain the structure of urban freight movement and its growing last-mile component [Familiarity]
2. Design a loading-zone or delivery-management scheme for a commercial street [Usage]
3. Evaluate an urban freight strategy for its effects on congestion, safety, and street-space conflicts [Assessment]

C.6.8 MOB/Road Safety, Emissions, and Mobility Evaluation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Methods for evaluating the safety and environmental performance of urban mobility systems, and strategies to reduce crashes and transport emissions.
Topics:
Core
- Crash data collection, hotspot identification, and analysis of road-safety performance

- The safe-system approach to road safety and its application to urban street networks
- Sources and measurement of transport-related greenhouse-gas and air-pollutant emissions
- Electrification, mode shift, and demand-management strategies to reduce transport emissions
- Metrics beyond vehicle speed for evaluating mobility-system performance, including safety and emissions
- Transport impact assessment procedures for new developments and infrastructure projects

Learning Outcomes:
Core:

1. Describe methods for analyzing road-safety and transport-emissions performance [Familiarity]
2. Analyze crash or emissions data to identify priority locations for safety or emissions interventions [Usage]
3. Evaluate a mobility plan for its projected safety and emissions outcomes [Assessment]

C.7 Infrastructure, Services, and Urban Systems (INF)

Planning and management of the engineered networks and facilities that support urban life, including water, energy, waste, transport connectivity, social facilities, green infrastructure, and infrastructure finance.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.7.1 Water, Sanitation, and Urban Drainage Networks (Pg.. 326)	1	1
⭐ C.7.2 Energy and Utility Networks (Pg.. 327)	1	1
⭐ C.7.3 Waste and Urban Circular Economy (Pg.. 327)	1	1
⭐ C.7.4 Transport Infrastructure and Connectivity (Pg.. 327)	1	1
⭐ C.7.5 Urban Facilities and Services (Pg.. 328)	1	1
⭐ C.7.6 Blue-Green Infrastructure and Nature-Based Solutions (Pg.. 328)	1	1
⭐ C.7.7 Coordination of Networks and Urban Asset Management (Pg.. 329)	1	1
⭐ C.7.8 Financing, Operation, and Maintenance of Infrastructure (Pg.. 329)	1	1

Table C.7: List of KUs in the Infrastructure, Services, and Urban Systems area.

C.7.1 INF/Water, Sanitation, and Urban Drainage Networks (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning dimensions of urban water supply, sewerage, and drainage networks, and their integration with urban growth and land use.
Topics:
Core

- Urban water-supply network planning, service coverage, and demand projection
- Sewerage network planning and its coordination with urban growth and densification
- Stormwater drainage planning and its relationship to impervious surface and urban form
- Coverage gaps in informal and peripheral areas and strategies to extend water and sanitation service
- Institutional arrangements for water-utility operation, regulation, and tariff setting
- Urban planning responses to water scarcity, including demand management and alternative sources

Learning Outcomes:
Core:

1. Describe the components of urban water, sanitation, and drainage networks and their planning implications [Familiarity]
2. Analyze service-coverage gaps in water and sanitation for a growing urban area [Usage]
3. Evaluate a water and sanitation extension plan for coverage, cost, and coordination with urban growth [Assessment]

C.7.2 INF/Energy and Utility Networks (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning considerations for urban energy and utility networks, including electricity distribution, renewable integration, and energy access.

Topics:

Core

- Urban electricity distribution networks and their relationship to density and land use
- Urban energy-demand projection and its drivers, including density, climate, and economic activity
- Distributed and renewable generation, including rooftop solar, integrated into urban energy systems
- Utility corridors, easements, and coordination of underground and overhead infrastructure
- Energy access gaps in informal and peripheral urban areas
- District energy and shared-infrastructure approaches to urban energy provision

Learning Outcomes:

Core:

1. Explain how urban form and density influence energy-network planning and demand [Familiarity]
2. Analyze energy-access gaps and distributed-generation potential for an urban area [Usage]
3. Evaluate an urban energy-infrastructure plan for coverage, resilience, and integration with renewables [Assessment]

C.7.3 INF/Waste and Urban Circular Economy (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning for solid-waste collection, treatment, and disposal, and strategies that shift urban material flows toward circularity.

Topics:

Core

- Waste-generation estimation and its relationship to population, income, and land use
- Collection-route planning, transfer stations, and informal-recycler integration
- Siting considerations for treatment, recycling, and disposal facilities relative to urban growth
- Reduction, reuse, and material-recovery strategies that reduce urban waste generation
- Integration of informal waste pickers into formal urban waste-management systems
- Construction and demolition waste management within urban development processes

Learning Outcomes:

Core:

1. Describe components of urban waste-management systems and circular-economy strategies [Familiarity]
2. Design a waste-collection and material-recovery scheme for a defined urban area [Usage]
3. Evaluate a waste-management plan for coverage, circularity, and inclusion of informal recyclers [Assessment]

C.7.4 INF/Transport Infrastructure and Connectivity (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning of major transport infrastructure – roads, bridges, ports, and terminals – that connects urban areas to broader territorial and logistics networks.

Topics:

Core

- Primary and arterial road-network planning connecting urban areas to regional systems
- Bridges, tunnels, and other structures connecting urban areas across physical barriers
- Ports, airports, and logistics terminals and their urban-land-use interfaces
- Right-of-way reservation and corridor protection for future infrastructure needs
- Integration of large infrastructure with surrounding urban fabric to minimize severance effects
- Connectivity planning linking cities to regional and national infrastructure networks

Learning Outcomes:
Core:

1. Describe major transport-infrastructure types and their role in urban and territorial connectivity [Familiarity]
2. Analyze the urban-integration effects of a major transport-infrastructure corridor [Usage]
3. Evaluate a connectivity-infrastructure plan for severance effects, land-use integration, and regional benefit [Assessment]

C.7.5 INF/Urban Facilities and Services (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning for the location, capacity, and distribution of public facilities and services that support everyday urban life.
Topics:
Core

- Education, health, security, and administrative facilities as components of urban service provision
- Population-based service standards for facility capacity and distribution
- Location-allocation methods for siting public facilities to maximize coverage and minimize travel
- Identification of underserved areas through facility-coverage and demand analysis
- Shared and multi-use facilities that increase efficiency of public investment
- Coordination of facility planning with housing, transport, and land-use plans

Learning Outcomes:
Core:

1. Explain population-based standards used to plan the distribution of urban facilities [Familiarity]
2. Analyze facility coverage for an urban area and identify underserved populations [Usage]
3. Evaluate a facility-provision plan for equity, accessibility, and coordination with other urban systems [Assessment]

C.7.6 INF/Blue-Green Infrastructure and Nature-Based Solutions (Core Tier1: 1 hr, Core Tier2: 1 hr)

Infrastructure systems that use natural or nature-based processes to manage water, heat, and ecological function as an alternative or complement to conventional grey infrastructure.
Topics:
Core

- Blue and green infrastructure concepts and their relationship to conventional engineered infrastructure
- Nature-based solutions for drainage, heat, and ecological function in dense urban contexts
- Bioswales, rain gardens, permeable surfaces, and sustainable urban drainage system components
- Networked blue-green systems connecting individual installations into citywide infrastructure
- Co-benefits of blue-green infrastructure for water management, heat reduction, biodiversity, and amenity
- Maintenance requirements and long-term performance of blue-green infrastructure installations

Learning Outcomes:
Core:

1. Describe blue-green infrastructure components and their co-benefits relative to conventional infrastructure [Familiarity]
2. Design a blue-green infrastructure intervention to manage stormwater in an urban catchment [Usage]
3. Evaluate a blue-green infrastructure plan for performance, co-benefits, and maintenance feasibility [Assessment]

C.7.7 INF/Coordination of Networks and Urban Asset Management (Core Tier1: 1 hr, Core Tier2: 1 hr)

Coordination among multiple infrastructure networks and systematic management of urban infrastructure assets over their lifecycle.

Topics:

Core

- Coordination mechanisms among water, energy, transport, and telecommunications utilities operating in shared urban space
- Asset inventories, condition assessment, and spatial asset-management databases
- Infrastructure lifecycle planning: design, construction, operation, maintenance, and renewal
- Risk-based prioritization of infrastructure renewal and investment decisions
- Coordination of underground utility works to reduce street disruption and conflicts
- Geographic information systems and digital tools supporting infrastructure asset management

Learning Outcomes:

Core:

1. Explain the components of an infrastructure asset-management system across the asset lifecycle [Familiarity]
2. Develop a coordination protocol for multiple utilities operating in a shared urban corridor [Usage]
3. Evaluate an infrastructure asset-management program for risk-based prioritization and coordination effectiveness [Assessment]

C.7.8 INF/Financing, Operation, and Maintenance of Infrastructure (Core Tier1: 1 hr, Core Tier2: 1 hr)

Financial and institutional mechanisms for funding, operating, and maintaining urban infrastructure over its service life.

Topics:

Core

- Public budgets, loans, bonds, and concessional finance for urban infrastructure capital investment
- Tariff design and user-charge structures for infrastructure cost recovery
- Budgeting for operations and maintenance distinct from capital investment
- Economic and financial appraisal of infrastructure projects prior to investment approval
- Consequences of deferred maintenance and strategies to secure recurrent funding
- Multilateral, national, and municipal institutions that finance urban infrastructure

Learning Outcomes:

Core:

1. Describe financing sources and cost-recovery mechanisms for urban infrastructure [Familiarity]
2. Develop a financing and operations-and-maintenance plan for a proposed infrastructure project [Usage]
3. Evaluate an infrastructure project's financial sustainability across its capital and operating lifecycle [Assessment]

C.8 Environment, Climate, and Urban Resilience (RES)

Environmental processes shaping cities and the planning responses that build resilience to climate change, natural hazards, and environmental health risks.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.8.1 Urban Ecology and City Metabolism (Pg.. 330)	1	1
⭐ C.8.2 Urban Climate, Heat Island, and Outdoor Comfort (Pg.. 330)	1	1
⭐ C.8.3 Climate Change: Mitigation and Adaptation (Pg.. 331)	1	1
⭐ C.8.4 Natural Hazards and Disaster Risk Reduction (Pg.. 331)	1	1
⭐ C.8.5 Urban Water, Watersheds, and Sustainable Drainage (Pg.. 331)	1	1
⭐ C.8.6 Biodiversity, Ecological Connectivity, and Ecosystem Services (Pg.. 332)	1	1
⭐ C.8.7 Environmental Health, Pollution, and Exposure (Pg.. 332)	1	1
⭐ C.8.8 Resilience, Recovery, and Emergency Planning (Pg.. 333)	1	1

Table C.8: List of KUs in the Environment, Climate, and Urban Resilience area.

C.8.1 RES/Urban Ecology and City Metabolism (Core Tier1: 1 hr, Core Tier2: 1 hr)

Cities as ecological and metabolic systems, including flows of energy and materials and the ecological processes operating within urban environments.

Topics:

Core

- Cities as novel ecosystems and the ecology-in, ecology-of, and ecology-for-cities framings
- Material and energy flow analysis describing inputs, transformations, and outputs of the urban system
- Urban flora and fauna, habitat fragmentation, and species adaptation to urban conditions
- Nutrient cycling, hydrology, and other ecosystem processes operating within the urban environment
- Field methods and indicators used to study urban ecological conditions
- Design-with-nature principles applying ecological understanding to urban form and infrastructure

Learning Outcomes:

Core:

1. Describe cities as ecological and metabolic systems and the flows that sustain them [Familiarity]
2. Analyze material and energy flows for an urban area using a metabolism framework [Usage]
3. Evaluate an urban development proposal for its ecological and metabolic implications [Assessment]

C.8.2 RES/Urban Climate, Heat Island, and Outdoor Comfort (Core Tier1: 1 hr, Core Tier2: 1 hr)

Processes that shape local urban climate, including the urban heat island effect, and their implications for outdoor thermal comfort.

Topics:

Core

- Surface energy balance, albedo, and other processes generating distinctive urban microclimates
- Causes, measurement, and spatial patterns of the urban heat island effect
- Thermal comfort indices and factors influencing comfort in outdoor urban spaces
- Urban canyon effects, wind patterns, and ventilation corridors in dense urban areas
- Reflective surfaces, shading, vegetation, and other heat-mitigation design strategies
- Urban form and orientation strategies responsive to local climate conditions

Learning Outcomes:

Core:

1. Explain the causes of the urban heat island and its effects on outdoor thermal comfort [Familiarity]
2. Assess heat-island intensity and comfort conditions for a specific urban area [Usage]
3. Evaluate an urban design proposal for its heat-mitigation and comfort performance [Assessment]

C.8.3 RES/Climate Change: Mitigation and Adaptation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Urban contributions to climate change and planning strategies for reducing emissions and adapting to a changing climate.

Topics:

Core

- Buildings, transport, and waste as principal sources of urban greenhouse-gas emissions
- Urban mitigation strategies: compact growth, efficient buildings, low-carbon transport, and renewable energy
- Methods for assessing urban exposure, sensitivity, and adaptive capacity to climate hazards
- Adaptation strategies for heat, flooding, drought, and sea-level rise in urban areas
- Municipal climate action plans, targets, and their integration with urban development plans
- Climate finance mechanisms available to support urban mitigation and adaptation investment

Learning Outcomes:

Core:

1. Describe principal sources of urban emissions and categories of climate adaptation strategy [Familiarity]
2. Assess climate vulnerability for an urban area across key hazard exposures [Usage]
3. Evaluate a municipal climate action plan for ambition, feasibility, and integration with urban planning [Assessment]

C.8.4 RES/Natural Hazards and Disaster Risk Reduction (Core Tier1: 1 hr, Core Tier2: 1 hr)

Identification and reduction of urban exposure to natural hazards, integrating risk assessment into urban planning and development decisions.

Topics:

Core

- Seismic, flood, landslide, volcanic, and tsunami hazards relevant to urban areas
- Hazard, exposure, and vulnerability components of urban disaster-risk assessment
- Integration of hazard and risk mapping into land-use plans and zoning restrictions
- Structural protection measures and nonstructural measures such as early warning and land-use control
- Institutional frameworks and responsibilities for disaster-risk reduction at national and municipal levels
- Peru's seismic, El Niño flooding, and landslide risk context and its planning implications

Learning Outcomes:

Core:

1. Identify principal natural hazards affecting an urban area and their basic risk components [Familiarity]
2. Map hazard exposure and vulnerability for an urban area to inform risk-sensitive land-use decisions [Usage]
3. Evaluate a land-use or development plan for its treatment of disaster-risk reduction [Assessment]

C.8.5 RES/Urban Water, Watersheds, and Sustainable Drainage (Core Tier1: 1 hr, Core Tier2: 1 hr)

Watershed-scale perspectives on urban water management, including the hydrological effects of urbanization and sustainable drainage approaches.

Topics:

Core

- Watershed delineation and hydrological processes affecting urban water systems
- Effects of impervious surface and urbanization on runoff volume, peak flow, and water quality
- Floodplain mapping, encroachment, and management approaches for urban watercourses

- Low-impact development and sustainable drainage principles applied at the site and catchment scale
- Water-sensitive urban design integrating hydrological function into urban form
- Institutional coordination required for watershed-scale urban water management across jurisdictions

Learning Outcomes:
Core:

1. Explain how urbanization alters watershed hydrology and the principles of sustainable drainage [Familiarity]
2. Analyze watershed-scale hydrological effects of a proposed urban development [Usage]
3. Evaluate a drainage or watershed-management plan for its hydrological and ecological performance [Assessment]

C.8.6 RES/Biodiversity, Ecological Connectivity, and Ecosystem Services (Core Tier1: 1 hr, Core Tier2: 1 hr)

Urban biodiversity conservation, ecological connectivity across fragmented landscapes, and the services ecosystems provide to urban populations.
Topics:
Core

- Patterns and drivers of species richness and composition across urban gradients
- Habitat fragmentation and loss of connectivity caused by urban expansion
- Ecological corridors, stepping stones, and network approaches to maintaining connectivity
- Provisioning, regulating, supporting, and cultural ecosystem-service categories applied to urban contexts
- Methods for valuing and mapping ecosystem services provided by urban green and blue space
- Planning instruments that protect biodiversity and ecological connectivity within urban development

Learning Outcomes:
Core:

1. Describe ecosystem-service categories and the effects of urbanization on biodiversity and connectivity [Familiarity]
2. Map ecological connectivity and ecosystem-service provision for an urban or peri-urban area [Usage]
3. Evaluate a development plan for its effects on biodiversity, connectivity, and ecosystem services [Assessment]

C.8.7 RES/Environmental Health, Pollution, and Exposure (Core Tier1: 1 hr, Core Tier2: 1 hr)

Relationships between urban environmental conditions and human health, including air and noise pollution, contaminated sites, and exposure disparities.
Topics:
Core

- Sources, measurement, and health effects of urban air pollution
- Urban noise sources, measurement, and health and quality-of-life effects
- Identification and management of contaminated and brownfield sites within urban areas
- Unequal distribution of environmental hazards and exposure across income and social groups
- Health-in-all-policies approaches integrating health considerations into urban planning decisions
- Indicators linking urban environmental conditions to population health outcomes

Learning Outcomes:
Core:

1. Describe principal urban environmental health hazards and their measurement [Familiarity]
2. Analyze the distribution of an environmental health hazard across an urban population [Usage]

3. Evaluate an urban plan for its environmental health implications and exposure equity [Assessment]

C.8.8 RES/Resilience, Recovery, and Emergency Planning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Planning for urban resilience to shocks and stresses, and the organization of recovery and emergency response following disasters.

Topics:

Core

- Engineering, ecological, and evolutionary resilience concepts applied to urban systems
- Emergency-response planning, evacuation routes, and shelter provision for urban populations
- Phases of post-disaster recovery, from emergency response through reconstruction
- Build-back-better principles integrating risk reduction into reconstruction planning
- Institutional and community capacities required to plan for and sustain resilience over time
- Distinguishing chronic urban stresses from acute shocks in resilience planning

Learning Outcomes:

Core:

1. Describe resilience concepts and the phases of post-disaster urban recovery [Familiarity]
2. Develop an emergency-preparedness or recovery framework for a hazard-exposed urban area [Usage]
3. Evaluate a resilience strategy for its treatment of chronic stresses, acute shocks, and recovery capacity [Assessment]

C.9 Economy, Governance, and Urban Management (GOV)

Economic, institutional, legal, and managerial dimensions of urban development, including land and real estate markets, municipal finance, governance, law, project management, partnerships, and public ethics.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.9.1 Urban Economy and Location (Pg.. 333)	1	1
⭐ C.9.2 Land Economy and Real Estate Markets (Pg.. 334)	1	1
⭐ C.9.3 Municipal Finance and Urban Budget (Pg.. 334)	1	1
⭐ C.9.4 Institutions, Competencies, and Multilevel Governance (Pg.. 335)	1	1
⭐ C.9.5 Urban Law and Regulatory Frameworks (Pg.. 335)	1	1
⭐ C.9.6 Urban Project and Program Management (Pg.. 335)	1	1
⭐ C.9.7 Public-Private Partnerships and Community Participation (Pg.. 336)	1	1
⭐ C.9.8 Public Ethics, Transparency, and Accountability (Pg.. 336)	1	1

Table C.9: List of KUs in the Economy, Governance, and Urban Management area.

C.9.1 GOV/Urban Economy and Location (Core Tier1: 1 hr, Core Tier2: 1 hr)

Economic principles explaining why cities exist, how activities locate within them, and how agglomeration shapes urban structure and productivity.

Topics:

Core

- Agglomeration economies, externalities, and their role in explaining urban concentration
- Bid-rent theory and location models explaining the spatial distribution of urban land uses
- Sectoral composition, export base, and economic specialization of cities
- Relationships between city size, density, and labor productivity
- Urban labor-market dynamics, commuting, and spatial mismatch between jobs and housing
- Scale, structure, and spatial expression of the informal economy in Latin American cities

Learning Outcomes:
Core:

1. Explain agglomeration economies and their role in urban growth and location decisions [Familiarity]
2. Analyze the economic base and labor-market structure of an urban area [Usage]
3. Evaluate an economic-development strategy for its fit with a city's economic structure and comparative advantages [Assessment]

C.9.2 GOV/Land Economy and Real Estate Markets (Core Tier1: 1 hr, Core Tier2: 1 hr)

Functioning of urban land and property markets, including price formation, market cycles, and the interaction between regulation and real estate investment.
Topics:
Core

- Land-price formation, capitalization of amenities and regulation, and spatial price gradients
- Supply lags, market cycles, and boom-bust dynamics in urban real estate markets
- Residual land value, development feasibility analysis, and the economics of real estate projects
- Effects of land-use regulation on housing supply, prices, and development patterns
- Structure and dynamics of informal land and housing markets in Latin American cities
- Developers, investors, financial institutions, and households as actors in urban real estate markets

Learning Outcomes:
Core:

1. Describe how land and property prices are formed and how regulation affects real estate markets [Familiarity]
2. Calculate development feasibility and residual land value for a proposed urban project [Usage]
3. Evaluate a real estate market's response to a proposed planning or regulatory change [Assessment]

C.9.3 GOV/Municipal Finance and Urban Budget (Core Tier1: 1 hr, Core Tier2: 1 hr)

Sources and management of municipal revenue and expenditure, and the fiscal foundations for funding urban services and development.
Topics:
Core

- Property taxes, user charges, transfers, and other sources of municipal revenue
- Property-tax assessment, administration, and its role in funding urban services
- Municipal budget preparation, capital and recurrent expenditure, and participatory budgeting practices
- Intergovernmental fiscal transfers and their role in municipal finance in Peru and the region
- Municipal borrowing, creditworthiness, and debt management for capital investment
- Fiscal sustainability analysis balancing revenue capacity against service and infrastructure obligations

Learning Outcomes:
Core:

1. Describe principal sources of municipal revenue and categories of municipal expenditure [Familiarity]
2. Analyze a municipal budget for revenue composition, expenditure priorities, and fiscal balance [Usage]
3. Evaluate a municipality's fiscal capacity to sustain a proposed urban investment program [Assessment]

C.9.4 GOV/Institutions, Competencies, and Multilevel Governance (Core Tier1: 1 hr, Core Tier2: 1 hr)

Institutional architecture of urban governance, including the distribution of competencies across levels of government and mechanisms for intergovernmental coordination.

Topics:

Core

- National, regional, and municipal government roles and competencies in urban development
- Decentralization reforms and their effects on local planning authority and capacity
- Mechanisms for coordinating urban policy across levels and sectors of government
- Organizational structures and mandates of municipal planning agencies
- Strategies for building technical and administrative capacity in local planning institutions
- Peru's institutional framework for urban governance, including municipal competencies and sectoral ministries

Learning Outcomes:

Core:

1. Describe the distribution of urban planning competencies across levels of government [Familiarity]
2. Analyze an intergovernmental coordination problem affecting urban plan implementation [Usage]
3. Evaluate an institutional arrangement for its capacity to deliver effective urban governance [Assessment]

C.9.5 GOV/Urban Law and Regulatory Frameworks (Core Tier1: 1 hr, Core Tier2: 1 hr)

Legal foundations of urban planning authority, property rights, and the regulatory instruments through which plans acquire binding force.

Topics:

Core

- Constitutional and statutory basis for public regulation of private land use
- Property rights, takings, and the balance between private rights and public planning authority
- Legal status and enforceability of plans, zoning ordinances, and development permits
- Administrative procedures for plan adoption, appeal, and judicial review
- Integration of environmental law and impact-assessment requirements into urban planning procedures
- Comparative perspectives on urban-law traditions and their implications for planning practice

Learning Outcomes:

Core:

1. Describe the legal basis for planning authority and the main regulatory instruments it produces [Familiarity]
2. Apply the relevant legal framework to assess the validity of a proposed planning action [Usage]
3. Evaluate a planning dispute for its legal merits and procedural compliance [Assessment]

C.9.6 GOV/Urban Project and Program Management (Core Tier1: 1 hr, Core Tier2: 1 hr)

Management methods for planning, executing, and controlling urban development projects and programs involving multiple actors and phases.

Topics:

Core

- Initiation, planning, execution, monitoring, and closure phases of urban project management
- Identification and management of stakeholders across public, private, and community interests in urban projects
- Scheduling, budgeting, and cost-control techniques applied to urban development projects
- Identification and management of risk across the lifecycle of an urban project

- Coordination of multiple related projects within a broader urban development program
- Procurement models and contracting approaches for public urban development projects

Learning Outcomes:

Core:

1. Describe the phases and core management techniques of an urban development project [Familiarity]
2. Develop a project-management plan, including schedule, budget, and risk register, for an urban project [Usage]
3. Evaluate the management performance of an urban project against its schedule, budget, and quality objectives [Assessment]

C.9.7 GOV/Public-Private Partnerships and Community Participation (Core Tier1: 1 hr, Core Tier2: 1 hr)

Arrangements through which public, private, and community actors collaborate to deliver urban infrastructure, services, and development.

Topics:

Core

- Concession, build-operate-transfer, and other public-private partnership models for urban infrastructure
- Risk-allocation principles between public and private partners in urban PPPs
- Contract structure, performance standards, and payment mechanisms in urban PPP agreements
- Partnerships between local government and community organizations for service delivery and project implementation
- Transparency, competitive procurement, and oversight safeguards for PPP arrangements
- Methods for evaluating whether a PPP delivers better value than conventional public procurement

Learning Outcomes:

Core:

1. Explain common public-private partnership models and their risk-allocation logic [Familiarity]
2. Design a partnership structure appropriate to a specific urban infrastructure or service project [Usage]
3. Evaluate a public-private partnership proposal for risk allocation, value for money, and public accountability [Assessment]

C.9.8 GOV/Public Ethics, Transparency, and Accountability (Core Tier1: 1 hr, Core Tier2: 1 hr)

Ethical standards and accountability mechanisms governing public decision-making in urban planning and management.

Topics:

Core

- Public interest, conflicts of interest, and the ethical foundations of planning as a public profession
- Open data, public hearings, and disclosure requirements supporting transparent urban decision-making
- Oversight bodies, audits, and institutions holding urban authorities accountable
- Corruption risks in land-use decisions and procurement, and safeguards to mitigate them
- Professional codes of conduct guiding planners' and urban managers' ethical practice
- Citizen oversight and participatory accountability mechanisms in urban governance

Learning Outcomes:

Core:

1. Describe transparency and accountability mechanisms applicable to urban governance decisions [Familiarity]
2. Identify ethical risks and conflicts of interest in a specific urban planning decision [Usage]

3. Evaluate an urban governance process for its transparency, accountability, and ethical integrity [Assessment]

C.10 Research Methods, Technologies, and Professional Practice (TEC)

Research methods, emerging digital technologies, and professional practice competencies that support rigorous, technologically current, and collaborative urban planning work.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ C.10.1 Qualitative Methods and Fieldwork (Pg.. 337)	1	1
⭐ C.10.2 Quantitative Methods and Statistical Analysis (Pg.. 337)	1	1
⭐ C.10.3 Participatory Research and Mixed Methods (Pg.. 338)	1	1
⭐ C.10.4 Digital Twins and Three-Dimensional Urban Models (Pg.. 338)	1	1
⭐ C.10.5 Sensors, Urban Data, and Civic Technology (Pg.. 339)	1	1
⭐ C.10.6 Artificial Intelligence and Urban Analytics (Pg.. 339)	1	1
⭐ C.10.7 Evaluation of Policies and Urban Impact (Pg.. 339)	1	1
⭐ C.10.8 Communication, Interdisciplinary Collaboration, and Professional Practice (Pg.. 340)	1	1

Table C.10: List of KUs in the Research Methods, Technologies, and Professional Practice area.

C.10.1 TEC/Qualitative Methods and Fieldwork (Core Tier1: 1 hr, Core Tier2: 1 hr)

Qualitative research approaches and fieldwork techniques used to understand urban social processes, meanings, and lived experience.

Topics:

Core

- Case study, ethnography, and grounded-theory traditions applied to urban research
- Semi-structured and in-depth interview design, sampling, and conduct
- Direct observation, behavior mapping, and ethnographic fieldwork in urban settings
- Coding, thematic analysis, and interpretation of qualitative urban-research data
- Informed consent, positionality, and ethical conduct of fieldwork in communities
- Credibility, transferability, and other criteria for rigor in qualitative urban research

Learning Outcomes:

Core:

1. Describe qualitative research traditions and fieldwork methods used in urban studies [Familiarity]
2. Conduct and document a qualitative fieldwork exercise addressing an urban research question [Usage]
3. Evaluate a qualitative urban study for rigor, ethical conduct, and credibility of findings [Assessment]

C.10.2 TEC/Quantitative Methods and Statistical Analysis (Core Tier1: 1 hr, Core Tier2: 1 hr)

Statistical methods for analyzing urban data, testing hypotheses, and supporting evidence-based planning decisions.

Topics:

Core

- Descriptive statistics and exploratory data analysis applied to urban datasets
- Hypothesis testing, confidence intervals, and inferential statistics for urban research questions
- Regression modeling for explaining and predicting urban phenomena
- Sampling design and survey-instrument construction for quantitative urban research
- Statistical methods accounting for spatial dependence in urban data

- Statistical software tools used for processing and analyzing urban quantitative data

Learning Outcomes:

Core:

1. Explain descriptive and inferential statistical methods applicable to urban data [Familiarity]
2. Apply a regression or inferential method to analyze an urban dataset and interpret results [Usage]
3. Evaluate a quantitative urban analysis for appropriateness of method, assumptions, and interpretation [Assessment]

C.10.3 TEC/Participatory Research and Mixed Methods (Core Tier1: 1 hr, Core Tier2: 1 hr)

Research approaches that engage communities as co-researchers and combine qualitative and quantitative evidence for urban planning.

Topics:

Core

- Participatory action research principles and cycles of inquiry and action
- Community mapping techniques for capturing local spatial knowledge
- Sequential and concurrent mixed-methods research designs combining qualitative and quantitative data
- Triangulation of data sources and methods to strengthen validity of urban research findings
- Community members' roles as co-researchers, and power dynamics in participatory research
- Limitations, biases, and resource demands of participatory research approaches

Learning Outcomes:

Core:

1. Describe principles of participatory action research and mixed-methods design [Familiarity]
2. Design a mixed-methods, participatory research approach for an urban planning question [Usage]
3. Evaluate a participatory research process for inclusiveness, validity, and influence on outcomes [Assessment]

C.10.4 TEC/Digital Twins and Three-Dimensional Urban Models (Core Tier1: 1 hr, Core Tier2: 1 hr)

Three-dimensional and dynamic digital representations of cities used for analysis, simulation, and decision support.

Topics:

Core

- Three-dimensional city model standards, building massing, and level-of-detail concepts
- Digital twin concepts, real-time data integration, and their distinction from static 3D models
- Applications of digital twins for infrastructure management, scenario testing, and public engagement
- Integration of building information modeling data into city-scale digital models
- Open standards and interoperability requirements for sharing urban digital-twin data across platforms
- Data, cost, and governance limitations constraining digital-twin implementation in practice

Learning Outcomes:

Core:

1. Explain digital twin concepts and their applications in urban planning and management [Familiarity]
2. Use a three-dimensional city model to analyze or communicate an urban planning scenario [Usage]
3. Evaluate a proposed digital-twin application for its data requirements, interoperability, and governance [Assessment]

C.10.5 TEC/Sensors, Urban Data, and Civic Technology (Core Tier1: 1 hr, Core Tier2: 1 hr)

Sensing technologies and civic-technology platforms that generate real-time urban data and enable new forms of public engagement.

Topics:

Core

- Environmental, traffic, and infrastructure sensors generating real-time urban data
- Internet-of-things architectures for collecting and transmitting urban sensor data
- Crowdsourced and citizen-generated data as a complement to formal sensor networks
- Civic-technology platforms for reporting, participation, and service-request management
- Data management, storage, and processing challenges of high-frequency urban sensor data
- Coverage bias, maintenance, and representativeness limitations of urban sensor networks

Learning Outcomes:

Core:

1. Describe types of urban sensors and civic-technology platforms and the data they generate [Familiarity]
2. Use sensor or civic-technology data to analyze a real-time urban condition [Usage]
3. Evaluate an urban sensing or civic-technology initiative for coverage, representativeness, and usefulness [Assessment]

C.10.6 TEC/Artificial Intelligence and Urban Analytics (Core Tier1: 1 hr, Core Tier2: 1 hr)

Application of artificial intelligence and advanced analytics to understand, predict, and support decisions about urban systems.

Topics:

Core

- Machine learning and advanced analytics applications across urban planning domains
- Predictive models for land-use change, travel demand, and other urban processes
- Computer-vision and sensor-analytics applications for monitoring urban conditions
- Algorithmic decision-support tools applied to planning and resource-allocation problems
- Governance, bias, and accountability considerations for AI used in urban decision-making
- Generative AI applications for scenario generation, visualization, and planning-document drafting

Learning Outcomes:

Core:

1. Describe applications and limitations of artificial intelligence and analytics in urban planning [Familiarity]
2. Apply an analytics or AI tool to a specific urban planning or decision-support task [Usage]
3. Evaluate an AI-based planning tool for accuracy, bias, transparency, and appropriate use [Assessment]

C.10.7 TEC/Evaluation of Policies and Urban Impact (Core Tier1: 1 hr, Core Tier2: 1 hr)

Systematic methods for evaluating the implementation, outcomes, and impact of urban plans, programs, and policies.

Topics:

Core

- Process, outcome, and impact evaluation frameworks applied to urban policy
- Counterfactual and quasi-experimental designs for attributing outcomes to urban interventions
- Indicator-based evaluation approaches linking monitoring data to policy assessment
- Cost-benefit and cost-effectiveness analysis applied to urban policy and project evaluation
- Utilization-focused and participatory approaches that involve stakeholders in evaluation design
- Translating evaluation findings into policy learning and plan revision

Learning Outcomes:
Core:

1. Describe frameworks and designs used to evaluate urban policies and programs [Familiarity]
2. Design an evaluation plan, including indicators and comparison strategy, for an urban program [Usage]
3. Evaluate a completed urban policy evaluation for methodological rigor and relevance to decision-making [Assessment]

C.10.8 TEC/Communication, Interdisciplinary Collaboration, and Professional Practice (Core Tier1: 1 hr, Core Tier2: 1 hr)

Communication skills and collaborative practices required for urbanism professionals to work effectively across disciplines and with diverse publics.
Topics:
Core

- Technical reports, planning documents, and memoranda appropriate to professional urbanism practice
- Diagrams, maps, and visual communication of technical analysis to non-technical audiences
- Public presentation and facilitation skills for hearings, workshops, and community meetings
- Collaboration with architects, engineers, economists, and social scientists on urban projects
- Professional codes of conduct, licensure, and standards of care in urbanism practice
- Continuing education and adaptation to new tools, regulations, and professional standards over a career

Learning Outcomes:
Core:

1. Describe communication formats and professional standards expected of urbanism practitioners [Familiarity]
2. Prepare a technical report and public presentation communicating an urban analysis to a mixed audience [Usage]
3. Evaluate a professional work product for clarity, interdisciplinary rigor, and ethical conduct [Assessment]

Appendix D

Body of knowledge of Project Management

The 9 knowledge areas in Project Management are:

D.1 Project Management Principles (PR) (Pg.. 341)
- D.1.1 Stewardship (Pg.. 342)
- D.1.2 Create a Collaborative Project Team Environment (Pg.. 342)
- D.1.3 Effectively Engage with Stakeholders (Pg.. 343)
- D.1.4 Focus on Value (Pg.. 343)
- D.1.5 Recognize, Evaluate, and Respond to System Interactions (Pg.. 343)
- D.1.6 Demonstrate Leadership Behaviors (Pg.. 344)
- D.1.7 Tailor Based on Context (Pg.. 344)
- D.1.8 Build Quality into Processes and Deliverables (Pg.. 345)
- D.1.9 Navigate Complexity (Pg.. 345)
- D.1.10 Optimize Risk Responses (Pg.. 345)
- D.1.11 Embrace Adaptability and Resiliency (Pg.. 346)
- D.1.12 Enable Change to Achieve the Envisioned Future State (Pg.. 346)

D.2 Stakeholders (ST) (Pg.. 346)
- D.2.1 Stakeholder Identification and Analysis (Pg.. 347)
- D.2.2 Stakeholder Engagement Planning (Pg.. 347)
- D.2.3 Stakeholder Communication and Relationships (Pg.. 347)
- D.2.4 Managing Stakeholder Expectations (Pg.. 348)
- D.2.5 Stakeholder Influence and Power (Pg.. 348)
- D.2.6 Conflict and Negotiation with Stakeholders (Pg.. 348)
- D.2.7 Monitoring Stakeholder Engagement (Pg.. 349)

D.3 Team (TM) (Pg.. 349)
- D.3.1 Project Team Culture (Pg.. 349)
- D.3.2 Team Leadership Styles (Pg.. 350)
- D.3.3 Team Development and Performance (Pg.. 350)
- D.3.4 Motivation and Empowerment (Pg.. 350)
- D.3.5 Collaboration and Trust Building (Pg.. 351)
- D.3.6 Distributed and Virtual Teams (Pg.. 351)
- D.3.7 Ethics and Professional Conduct (Pg.. 351)

D.4 Development Approach and Life Cycle (DL) (Pg.. 352)
- D.4.1 Kickoff and Closure Activities (Pg.. 352)
- D.4.2 Development Approach Selection (Pg.. 352)
- D.4.3 Predictive Approach (Pg.. 353)
- D.4.4 Adaptive Approach (Pg.. 353)
- D.4.5 Hybrid Approach (Pg.. 353)
- D.4.6 Project Phase Structure (Pg.. 354)
- D.4.7 Tailoring the Development Approach (Pg.. 354)

D.5 Planning (PL) (Pg.. 354)
- D.5.1 Planning Principles (Pg.. 355)
- D.5.2 Scope and Requirements Planning (Pg.. 355)
- D.5.3 Schedule Planning (Pg.. 355)
- D.5.4 Cost and Budget Planning (Pg.. 356)
- D.5.5 Resource Planning (Pg.. 356)
- D.5.6 Quality Planning (Pg.. 356)
- D.5.7 Risk and Uncertainty Planning (Pg.. 357)
- D.5.8 Communications and Stakeholder Engagement Planning (Pg.. 357)
- D.5.9 Procurement Planning (Pg.. 357)
- D.5.10 Integrated Project Planning (Pg.. 358)

D.6 Project Work (PW) (Pg.. 358)
- D.6.1 Managing Project Artifacts (Pg.. 358)
- D.6.2 Communication and Knowledge Management (Pg.. 359)
- D.6.3 Team Engagement During Execution (Pg.. 359)
- D.6.4 Stakeholder Engagement During Execution (Pg.. 359)
- D.6.5 Managing Physical Resources (Pg.. 360)
- D.6.6 Working with Procurements (Pg.. 360)
- D.6.7 Monitoring and Adapting Work (Pg.. 360)

D.7 Delivery (DV) (Pg.. 361)
- D.7.1 Value Definition and Delivery (Pg.. 361)
- D.7.2 Requirements and Scope Delivery (Pg.. 361)
- D.7.3 Quality Assurance and Delivery (Pg.. 362)
- D.7.4 Incremental and Iterative Delivery (Pg.. 362)
- D.7.5 Transition and Handover (Pg.. 362)
- D.7.6 Benefits Realization Management (Pg.. 363)
- D.7.7 Customer and User Satisfaction (Pg.. 363)

D.8 Measurement (MS) (Pg.. 363)
- D.8.1 Key Performance Indicators (Pg.. 363)
- D.8.2 Dashboards and Information Radiators (Pg.. 364)
- D.8.3 Measurement Purpose and Approach (Pg.. 364)
- D.8.4 Earned Value and Schedule Performance (Pg.. 364)
- D.8.5 Forecasting and Trends (Pg.. 365)
- D.8.6 Stakeholder Performance Reporting (Pg.. 365)
- D.8.7 Lessons Learned and Knowledge Capture (Pg.. 365)

D.9 Uncertainty (UN) (Pg.. 366)
- D.9.1 Understanding Uncertainty and Risk (Pg.. 366)
- D.9.2 Risk Identification and Assessment (Pg.. 366)
- D.9.3 Threat and Opportunity Response (Pg.. 367)
- D.9.4 Ambiguity Management (Pg.. 367)
- D.9.5 Complexity Management (Pg.. 368)
- D.9.6 Volatility and Resilience Strategies (Pg.. 368)
- D.9.7 Monitoring and Adapting to Uncertainty (Pg.. 368)

D.1 Project Management Principles (PR)

This knowledge area covers the twelve foundational principles introduced in PMBoK 7th edition (2021). These principles are not prescriptive rules but guiding behaviors and values that practitioners

use to navigate project decisions. They provide the ethical and professional foundation for all project management performance domains.

Knowledge Area (KA)	Core Tier1	Core Tier2
D.1.1 Stewardship (Pg.. 342)	Elective	
D.1.2 Create a Collaborative Project Team Environment (Pg.. 342)	Elective	
D.1.3 Effectively Engage with Stakeholders (Pg.. 343)	Elective	
D.1.4 Focus on Value (Pg.. 343)	Elective	
D.1.5 Recognize, Evaluate, and Respond to System Interactions (Pg.. 343)	Elective	
D.1.6 Demonstrate Leadership Behaviors (Pg.. 344)	Elective	
D.1.7 Tailor Based on Context (Pg.. 344)	Elective	
D.1.8 Build Quality into Processes and Deliverables (Pg.. 345)	Elective	
D.1.9 Navigate Complexity (Pg.. 345)	Elective	
D.1.10 Optimize Risk Responses (Pg.. 345)	Elective	
D.1.11 Embrace Adaptability and Resiliency (Pg.. 346)	Elective	
D.1.12 Enable Change to Achieve the Envisioned Future State (Pg.. 346)	Elective	

Table D.1: List of KUs in the Project Management Principles area.

D.1.1 PR/Stewardship

Being a diligent, respectful, and caring steward. Project practitioners act as stewards of the organization, project team, stakeholders, and the broader environment, balancing organizational and external factors in a responsible and ethical manner.

Topics:

Core

- Responsible and ethical conduct as a foundation of stewardship
- Acting as a steward of organizational resources: financial, human, material, and intellectual
- Stewardship of the external environment: sustainability, community impact, and societal responsibility
- Transparency, accountability, and honest reporting as stewardship behaviors
- Long-term thinking: balancing immediate project needs with long-term organizational and societal outcomes

Learning Outcomes:

Core:

1. Describe the concept of stewardship and its application to project management responsibilities [Familiarity]
2. Apply stewardship principles to make responsible resource and ethical decisions in a project context [Usage]
3. Evaluate project decisions from the perspective of stewardship toward the organization, stakeholders, and society [Assessment]

D.1.2 PR/Create a Collaborative Project Team Environment

Building a team environment characterized by shared ownership, mutual respect, and collaborative decision-making. This principle emphasizes that project outcomes emerge from collective team effort rather than individual heroics.

Topics:

Core

- Shared ownership of project goals and outcomes within the team
- Psychological safety: creating an environment where team members can contribute ideas and raise concerns without fear
- Collaborative decision-making and inclusive participation
- Clarity of roles, responsibilities, and accountabilities within the team
- Leveraging diversity and inclusion for team creativity and problem-solving

Learning Outcomes:
Core:
1. Explain how a collaborative team environment contributes to project success [Familiarity]
2. Foster shared ownership and psychological safety within a project team [Usage]
3. Design practices that promote inclusion and collaborative decision-making in a project team [Assessment]

D.1.3 PR/Effectively Engage with Stakeholders

Proactively engaging with stakeholders to understand their needs, interests, and concerns, and involving them in project decisions. Effective stakeholder engagement increases the likelihood of delivering value and achieving project success.
Topics:
Core
- Proactive stakeholder engagement throughout the project life cycle
- Understanding stakeholder interests, needs, expectations, and potential impact
- Two-way communication and feedback loops with stakeholders
- Adapting engagement strategies to evolving stakeholder needs and project context

Learning Outcomes:
Core:
1. Describe the importance of proactive stakeholder engagement as a project management principle [Familiarity]
2. Apply stakeholder engagement strategies that promote two-way communication and shared understanding [Usage]
3. Evaluate the effectiveness of stakeholder engagement approaches and propose improvements [Assessment]

D.1.4 PR/Focus on Value

Continually evaluating and adjusting project alignment with business outcomes and intended benefits. Value is the ultimate indicator of project success, and it may be defined differently by different stakeholders throughout the project.
Topics:
Core
- Defining value: tangible and intangible benefits, business outcomes, and stakeholder satisfaction
- Aligning project work continuously with the intended value and business case
- Benefits realization: ensuring delivered outcomes translate into actual organizational value
- Distinguishing between delivering scope and delivering value
- Strategies for early and incremental value delivery

Learning Outcomes:
Core:
1. Define value in the context of a project and identify how it differs across stakeholders [Familiarity]
2. Align project decisions and trade-offs with the intended value and business outcomes [Usage]
3. Evaluate whether a project's current trajectory is delivering the expected value and propose adjustments [Assessment]

D.1.5 PR/Recognize, Evaluate, and Respond to System Interactions

Understanding projects as components of a larger system with interdependencies, feedback loops, and emergent behaviors. Systems thinking helps project practitioners anticipate second-order effects and make better decisions.
Topics:
Core
- Systems thinking foundations: interdependencies, feedback loops, and emergent behaviors

- The project as a system embedded within organizational and environmental systems
- Anticipating second-order effects of project decisions on the broader system
- Systems mapping: visualizing interdependencies and influence relationships

Learning Outcomes:
Core:

1. Explain how systems thinking applies to project management decision-making [Familiarity]
2. Analyze a project situation using systems thinking to identify interdependencies and potential second-order effects [Usage]
3. Apply systems mapping to visualize the relationships between a project and its organizational environment [Assessment]

D.1.6 PR/Demonstrate Leadership Behaviors

Demonstrating and adapting leadership behaviors to support individual and team needs. Effective leadership in project management is not tied to a formal role - anyone on the project team can and should demonstrate leadership.
Topics:
Core

- Distinction between leadership and management in project contexts
- Adaptive leadership: adjusting style to context, team maturity, and situational needs
- Servant leadership: prioritizing team needs and removing obstacles to performance
- Key leadership behaviors: vision, influence, empathy, integrity, and decisiveness
- Shared and distributed leadership: empowering team members to lead within their domain

Learning Outcomes:
Core:

1. Describe the key leadership behaviors expected of project practitioners regardless of their role [Familiarity]
2. Demonstrate adaptive leadership behaviors appropriate to a given project team situation [Usage]
3. Evaluate the leadership climate of a project team and propose interventions to strengthen it [Assessment]

D.1.7 PR/Tailor Based on Context

Adapting the project approach, governance, and processes to fit the specific context of the project. Tailoring recognizes that no single methodology fits all projects, and that effective practitioners select and adapt their approach deliberately.
Topics:
Core

- The concept of tailoring: adapting frameworks, methods, and processes to context
- Factors that influence tailoring: project size, complexity, uncertainty, team maturity, and organizational culture
- Tailoring governance structures: approval levels, reporting requirements, and decision authorities
- Tailoring the life cycle and development approach to project-specific needs
- Continuously reassessing and adjusting tailoring decisions as the project evolves

Learning Outcomes:
Core:

1. Explain the purpose of tailoring and why a one-size-fits-all approach is insufficient in project management [Familiarity]
2. Apply tailoring criteria to select an appropriate project approach for a given project context [Usage]
3. Design a tailored project governance structure appropriate to a specific project's complexity and risk profile [Assessment]

D.1.8 PR/Build Quality into Processes and Deliverables

Maintaining focus on quality throughout the project by embedding quality into processes and deliverables rather than inspecting quality after the fact. Quality is defined by meeting requirements and fitness for purpose as perceived by stakeholders.

Topics:

Core

- Defining quality: meeting requirements, fitness for purpose, and stakeholder satisfaction
- Building quality in: prevention over inspection, shift-left testing, and continuous improvement
- Quality in processes: consistent execution, repeatability, and process improvement
- Balancing the cost of quality with the cost of poor quality

Learning Outcomes:

Core:

1. Describe the principle of building quality into project processes and deliverables [Familiarity]
2. Apply quality-by-design practices to embed quality checkpoints throughout the project life cycle [Usage]
3. Evaluate the trade-off between quality investment and the cost of poor quality in a project scenario [Assessment]

D.1.9 PR/Navigate Complexity

Using knowledge, experience, and learning to navigate complexity throughout the project. Complexity arises from human behavior, system interactions, and uncertainty, and cannot be eliminated but must be managed adaptively.

Topics:

Core

- Defining complexity: distinction from complicatedness, sources of complexity in projects
- Cynefin framework: simple, complicated, complex, and chaotic domains
- Indicators of project complexity: interdependencies, ambiguity, uncertainty, and innovation
- Strategies for navigating complexity: iterative approaches, experimentation, and emergent solutions
- Building team and organizational resilience to manage ongoing complexity

Learning Outcomes:

Core:

1. Describe the nature and sources of complexity in project environments [Familiarity]
2. Apply the Cynefin framework to classify a project situation and select an appropriate response approach [Usage]
3. Develop strategies for navigating a specific complex project situation [Assessment]

D.1.10 PR/Optimize Risk Responses

Constantly evaluating exposure to both threats and opportunities, and optimizing risk responses to maximize positive outcomes and minimize negative impacts. Risk optimization is an ongoing activity, not a one-time planning step.

Topics:

Core

- Viewing risk as both threat and opportunity: balanced risk mindset
- Continuous risk assessment throughout the project life cycle
- Optimizing risk responses: proportionality, cost-effectiveness, and timeliness
- Building a risk-aware culture: open communication about risks at all levels

Learning Outcomes:

Core:

1. Explain the principle of optimizing risk responses including both threats and opportunities [Familiarity]
2. Apply continuous risk assessment practices to identify and respond to emerging risks [Usage]
3. Evaluate the proportionality and cost-effectiveness of a set of risk responses [Assessment]

D.1.11 PR/Embrace Adaptability and Resiliency

Building adaptability and resiliency into the project and team to absorb the impacts of change and disruption. Adaptable teams respond effectively to changing requirements, unexpected events, and emerging information.

Topics:

Core

- Adaptability: the ability to respond effectively to changes in the project environment
- Resiliency: the capacity to absorb disruption and recover without loss of function
- Building change readiness in teams: flexible mindset, skills versatility, and open communication
- Organizational resilience and its relationship to project adaptability

Learning Outcomes:

Core:

1. Distinguish between adaptability and resiliency and explain their importance in project management [Familiarity]
2. Apply practices that build team adaptability and change readiness in a project environment [Usage]
3. Design a resilience strategy for a project team operating in a highly volatile environment [Assessment]

D.1.12 PR/Enable Change to Achieve the Envisioned Future State

Preparing those affected by the project for the transition from current state to future state. Projects create change, and enabling that change requires structured change management integrated with project delivery.

Topics:

Core

- Change management foundations: current state, transition state, and future state
- Assessing and building stakeholder readiness for organizational change
- Understanding and managing resistance to change in project-driven transformations
- Change management models: Kotter 8-step, ADKAR, and Prosci
- Embedding and sustaining change after project completion

Learning Outcomes:

Core:

1. Describe the role of change management as an integral part of project delivery [Familiarity]
2. Apply a change management model to plan and execute a project-driven organizational transition [Usage]
3. Evaluate stakeholder readiness for change and design interventions to reduce resistance [Assessment]

D.2 Stakeholders (ST)

This performance domain covers the activities and functions associated with stakeholders throughout the project. Effective stakeholder engagement requires understanding who stakeholders are, what they need, and how to involve them to maximize project value and minimize resistance.

Knowledge Area (KA)	Core Tier1	Core Tier2
D.2.1 Stakeholder Identification and Analysis (Pg.. 347)	Elective	
D.2.2 Stakeholder Engagement Planning (Pg.. 347)	Elective	
D.2.3 Stakeholder Communication and Relationships (Pg.. 347)	Elective	
D.2.4 Managing Stakeholder Expectations (Pg.. 348)	Elective	
D.2.5 Stakeholder Influence and Power (Pg.. 348)	Elective	
D.2.6 Conflict and Negotiation with Stakeholders (Pg.. 348)	Elective	
D.2.7 Monitoring Stakeholder Engagement (Pg.. 349)	Elective	

Table D.2: List of KUs in the Stakeholders area.

D.2.1 ST/Stakeholder Identification and Analysis

Identifying all individuals, groups, and organizations that could impact or be impacted by the project, and analyzing their interests, power, and engagement levels.

Topics:

Core

- Stakeholder identification techniques: brainstorming, organizational charts, expert interviews
- Stakeholder register: capturing identification, assessment, and classification data
- Power/interest grid and salience model for stakeholder prioritization
- Monitoring changes in the stakeholder landscape throughout the project

Learning Outcomes:

Core:

1. Identify and document project stakeholders using structured identification and analysis techniques [Usage]
2. Classify and prioritize stakeholders using a power/interest grid [Usage]
3. Monitor changes in the stakeholder landscape and update the stakeholder register accordingly [Assessment]

D.2.2 ST/Stakeholder Engagement Planning

Developing strategies and actions to promote productive stakeholder involvement based on analysis of their needs, interests, and current engagement levels.

Topics:

Core

- Engagement assessment matrix: current vs. desired engagement levels
- Tailored engagement strategies for different stakeholder profiles and engagement levels
- Integrating stakeholder engagement planning with the communications management approach
- Reviewing and updating the engagement plan at key project milestones and phase transitions

Learning Outcomes:

Core:

1. Develop a stakeholder engagement plan with tailored strategies for each key stakeholder group [Usage]
2. Integrate stakeholder engagement planning with communications and change management approaches [Assessment]
3. Evaluate the adequacy of a stakeholder engagement plan against project complexity and stakeholder diversity [Assessment]

D.2.3 ST/Stakeholder Communication and Relationships

Building and maintaining productive relationships with stakeholders through consistent, targeted communication. Covers active listening, feedback mechanisms, and trust-building.

Topics:

Core

- Active listening and empathy as foundations of stakeholder relationship-building
- Feedback mechanisms: soliciting, processing, and acting on stakeholder feedback
- Building and maintaining trust with diverse stakeholder groups
- Building stakeholder relationships in virtual and distributed environments

Learning Outcomes:

Core:

1. Apply active listening and feedback techniques to strengthen stakeholder relationships [Usage]
2. Design a relationship management approach for a complex multi-stakeholder project environment [Assessment]
3. Evaluate the effectiveness of stakeholder communication strategies and recommend improvements [Assessment]

D.2.4 ST/Managing Stakeholder Expectations

Aligning stakeholder expectations with project scope, constraints, and intended value. Proactively managing expectations prevents misalignment, reduces conflict, and builds stakeholder satisfaction.
Topics:
Core

- Aligning stakeholder expectations with project reality: scope, timeline, and value boundaries
- Proactive expectation setting: communicating early and clearly about constraints and trade-offs
- Identifying and closing expectation gaps through negotiation and re-scoping
- Documenting agreed expectations in the project charter, scope baseline, and meeting records

Learning Outcomes:
Core:

1. Align stakeholder expectations with project scope and constraints through proactive communication [Usage]
2. Resolve stakeholder expectation gaps through structured negotiation and trade-off analysis [Assessment]
3. Design a proactive expectation management approach for a project with diverse and conflicting stakeholder needs [Assessment]

D.2.5 ST/Stakeholder Influence and Power

Understanding and navigating stakeholder power, politics, and influence to advance project objectives. Includes ethical use of influence and managing political dynamics.
Topics:
Core

- Power dynamics in projects: formal authority, expert power, referent power, and resource control
- Navigating organizational politics to advance project objectives ethically
- Influencing without formal authority: coalition building, persuasion, and negotiation
- Building strategic alliances and sponsor relationships to advance project objectives

Learning Outcomes:
Core:

1. Identify different sources of stakeholder power and their implications for project management [Familiarity]
2. Apply ethical influence strategies to gain stakeholder support without formal authority [Assessment]
3. Evaluate the ethical boundaries of influence strategies in a specific stakeholder and organizational context [Assessment]

D.2.6 ST/Conflict and Negotiation with Stakeholders

Identifying, addressing, and resolving stakeholder conflicts constructively. Covers negotiation strategies and escalation paths for stakeholder disputes.
Topics:
Core

- Sources of stakeholder conflict: competing interests, resource scarcity, and communication failures
- Conflict resolution strategies: collaborate, compromise, accommodate, avoid, compete
- Principled negotiation: interests vs. positions, BATNA, and win-win framing
- Escalation paths and governance structures for unresolved stakeholder conflicts

Learning Outcomes:
Core:

1. Apply conflict resolution strategies to address a stakeholder dispute in a project scenario [Usage]
2. Negotiate a stakeholder agreement using principled negotiation techniques [Usage]
3. Design an escalation path for managing unresolved stakeholder conflicts [Assessment]

D.2.7 ST/Monitoring Stakeholder Engagement

Continuously monitoring the effectiveness of stakeholder engagement and adjusting strategies as the project evolves. Covers engagement metrics, feedback analysis, and adaptive response.
Topics:
Core

- Metrics for measuring stakeholder engagement effectiveness: participation rates, feedback scores, sentiment
- Periodic review of stakeholder engagement: updating the engagement assessment matrix
- Early warning signals of stakeholder disengagement or resistance
- Corrective actions for declining engagement: re-engagement workshops, escalation, and plan revision

Learning Outcomes:
Core:

1. Monitor stakeholder engagement using defined metrics and update engagement strategies [Usage]
2. Identify early signals of stakeholder disengagement and propose proactive responses [Assessment]
3. Evaluate the overall effectiveness of the stakeholder engagement approach and recommend adaptive changes [Assessment]

D.3 Team (TM)

This performance domain covers the activities and functions associated with the people responsible for producing project outcomes. It emphasizes leadership, team culture, skill development, and creating an environment where the team can perform at its best.

Knowledge Area (KA)	Core Tier1	Core Tier2
D.3.1 Project Team Culture (Pg.. 349)	Elective	
D.3.2 Team Leadership Styles (Pg.. 350)	Elective	
D.3.3 Team Development and Performance (Pg.. 350)	Elective	
D.3.4 Motivation and Empowerment (Pg.. 350)	Elective	
D.3.5 Collaboration and Trust Building (Pg.. 351)	Elective	
D.3.6 Distributed and Virtual Teams (Pg.. 351)	Elective	
D.3.7 Ethics and Professional Conduct (Pg.. 351)	Elective	

Table D.3: List of KUs in the Team area.

D.3.1 TM/Project Team Culture

Establishing and sustaining a healthy team culture characterized by trust, transparency, and shared values. Culture shapes how teams make decisions, resolve conflicts, and respond to adversity.
Topics:
Core

- Defining team culture: shared values, norms, behaviors, and communication patterns
- Psychological safety: enabling open dialogue, experimentation, and honest feedback
- Building trust and transparency as foundations of high-performing team culture
- Relationship between team culture and project performance outcomes

Learning Outcomes:
Core:

1. Describe the elements of a healthy project team culture and their impact on performance [Familiarity]
2. Apply practices that build psychological safety and trust within a project team [Usage]
3. Evaluate the current culture of a project team and propose targeted improvements [Assessment]

D.3.2 TM/Team Leadership Styles

Understanding and applying different leadership styles to meet the needs of the team and the project context. PMBoK 7th edition emphasizes servant leadership and situational adaptation.

Topics:

Core

- Servant leadership: removing obstacles, supporting team members, and enabling performance
- Situational leadership: matching leadership style to team member competence and commitment
- Transformational leadership: inspiring change, innovation, and team growth
- Distributed leadership: sharing leadership responsibilities across the team

Learning Outcomes:

Core:

1. Compare servant, situational, and transformational leadership styles and their applicability [Familiarity]
2. Apply situational leadership principles to a team member development scenario [Usage]
3. Select the most appropriate leadership approach for a given team and project context [Assessment]

D.3.3 TM/Team Development and Performance

Building team competencies, cohesion, and performance over the project life cycle. Covers team formation stages, performance indicators, and continuous development.

Topics:

Core

- Tuckman team development stages: forming, storming, norming, performing, adjourning
- Team performance indicators: velocity, quality of output, collaboration metrics
- Continuous team development: coaching, mentoring, and skill-building activities
- Characteristics and practices of high-performing project teams

Learning Outcomes:

Core:

1. Apply team development strategies appropriate to each stage of team formation [Usage]
2. Design a team development plan targeting high performance outcomes [Assessment]
3. Evaluate the current performance stage of a project team and select appropriate interventions to accelerate progression [Assessment]

D.3.4 TM/Motivation and Empowerment

Understanding what motivates team members and creating conditions for intrinsic motivation, autonomy, and ownership. Empowered teams make better decisions and deliver more value.

Topics:

Core

- Motivation theories: Maslow, Herzberg, self-determination theory, and Drive (Pink)
- Intrinsic motivation: autonomy, mastery, and purpose as drivers of team performance
- Empowerment practices: delegating decision-making, providing autonomy, and trusting team judgment
- Recognition and rewards: designing systems that reinforce desired team behaviors

Learning Outcomes:

Core:

1. Explain the key motivation theories and their application to project team management [Familiarity]
2. Apply empowerment practices to increase team autonomy and ownership of project outcomes [Usage]
3. Design a recognition and reward system aligned with intrinsic motivation principles [Assessment]

D.3.5 TM/Collaboration and Trust Building

Creating conditions for effective team collaboration through trust, clear agreements, and shared working practices. Covers team charters, collaboration tools, and conflict prevention.

Topics:

Core

- Team charter: defining working agreements, norms, communication expectations, and decision rights
- Collaboration tools and practices: shared workspaces, visual management, and daily stand-ups
- Trust models: competence-based and character-based trust in team relationships
- Proactive conflict prevention through clear agreements and early communication

Learning Outcomes:

Core:

1. Develop a team charter that establishes working agreements and collaboration norms [Usage]
2. Evaluate the level of trust and collaboration in a project team and propose targeted interventions [Assessment]
3. Design a conflict prevention strategy based on clear team agreements and proactive communication practices [Assessment]

D.3.6 TM/Distributed and Virtual Teams

Managing teams that are geographically distributed or operate virtually. Covers communication challenges, cultural differences, tools, and leadership practices for virtual environments.

Topics:

Core

- Challenges of virtual teams: communication lag, isolation, cultural differences, and time zones
- Digital collaboration tools for virtual teams: video conferencing, async communication, and shared workspaces
- Cultural intelligence (CQ): understanding and adapting to cultural differences in global teams
- Leadership practices specific to virtual and distributed team environments

Learning Outcomes:

Core:

1. Describe the unique challenges of managing distributed and virtual project teams [Familiarity]
2. Apply cultural intelligence and virtual collaboration practices to manage a distributed team [Usage]
3. Design a virtual team management approach that addresses communication, culture, and performance [Assessment]

D.3.7 TM/Ethics and Professional Conduct

Upholding ethical standards and professional conduct within the project team. Covers PMI's Code of Ethics, handling ethical dilemmas, and fostering an ethical team environment.

Topics:

Core

- PMI Code of Ethics: responsibility, respect, fairness, and honesty
- Recognizing and resolving ethical dilemmas in project team and stakeholder contexts
- Creating an inclusive, respectful, and psychologically safe team environment
- Ethical leadership: modeling integrity and accountability as a project leader

Learning Outcomes:

Core:

1. Describe the PMI Code of Ethics and its application to project team behavior [Familiarity]
2. Resolve an ethical dilemma in a project team context using principled reasoning [Usage]
3. Evaluate the ethical climate of a project team and propose leadership actions to strengthen it [Assessment]

D.4 Development Approach and Life Cycle (DL)

This performance domain covers the activities and functions associated with selecting, defining, and managing the development approach and the project life cycle. PMBoK 7th edition treats the choice of development approach as a deliberate, context-driven decision rather than a default.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ D.4.1 Kickoff and Closure Activities (Pg.. 352)	1	1
D.4.2 Development Approach Selection (Pg.. 352)	Elective	
D.4.3 Predictive Approach (Pg.. 353)	Elective	
D.4.4 Adaptive Approach (Pg.. 353)	Elective	
D.4.5 Hybrid Approach (Pg.. 353)	Elective	
D.4.6 Project Phase Structure (Pg.. 354)	Elective	
D.4.7 Tailoring the Development Approach (Pg.. 354)	Elective	

Table D.4: List of KUs in the Development Approach and Life Cycle area.

D.4.1 DL/Kickoff and Closure Activities (Core Tier1: 1 hr, Core Tier2: 1 hr)

Key activities at the start and end of the project and its phases. Covers project kickoff, phase transitions, and formal closure activities.

Topics:

Core

- Project kickoff: aligning team and stakeholders on objectives, approach, and working agreements
- Phase transition activities: reviews, approvals, and handoffs between phases
- Project closure: final deliverable acceptance, lessons learned, and team release
- Integrating lessons learned from closure into organizational knowledge assets

Learning Outcomes:

Core:

1. Conduct an effective project kickoff that aligns team and stakeholders on goals and approach [Usage]
2. Execute project closure activities including final acceptance and lessons learned archiving [Usage]
3. Design a comprehensive project closure checklist ensuring all administrative, contractual, and knowledge capture obligations are met [Assessment]

D.4.2 DL/Development Approach Selection

Selecting the most appropriate development approach - predictive, adaptive, or hybrid - based on project characteristics, organizational factors, and stakeholder needs.

Topics:

Core

- Overview of development approaches: predictive, iterative, incremental, adaptive, and hybrid
- Selection criteria: degree of uncertainty, rate of change, stakeholder involvement, and team capability
- Organizational factors influencing approach selection: culture, standards, and governance
- Evolving and adjusting the development approach as the project progresses

Learning Outcomes:

Core:

1. Select an appropriate development approach for a project based on defined selection criteria [Usage]
2. Justify the selected development approach given organizational and project-specific factors [Assessment]
3. Evaluate the alignment between a chosen development approach and the project's uncertainty level, team capability, and stakeholder engagement requirements [Assessment]

D.4.3 DL/Predictive Approach

Understanding when and how to apply a predictive (plan-driven) approach. Covers sequential phases, detailed upfront planning, and change management in predictive environments.

Topics:

Core

- Characteristics of predictive approach: sequential phases, fixed scope, and detailed upfront planning
- Conditions favoring predictive approach: stable requirements, low uncertainty, regulatory constraints
- Managing change in predictive environments: formal change control and baseline management
- Limitations of predictive approach in complex and uncertain environments

Learning Outcomes:

Core:

1. Describe the characteristics and appropriate use cases of a predictive development approach [Familiarity]
2. Apply predictive approach practices to plan and manage a project with stable requirements [Usage]
3. Evaluate when a predictive approach is or is not suitable for a given project context [Assessment]

D.4.4 DL/Adaptive Approach

Understanding when and how to apply adaptive (agile) approaches. Covers iterative and incremental delivery, backlog management, and empirical process control.

Topics:

Core

- Characteristics of adaptive approach: iterative delivery, evolving requirements, and empirical control
- Scrum and Kanban as representative adaptive frameworks
- Product backlog management: prioritization, refinement, and sprint planning
- Scaling adaptive approaches for large teams: SAFe, LeSS, and disciplined agile

Learning Outcomes:

Core:

1. Describe the characteristics and appropriate use cases of adaptive development approaches [Familiarity]
2. Apply adaptive approach practices including backlog management and iterative delivery [Usage]
3. Select an appropriate scaling framework for an adaptive approach in a large-team context [Assessment]

D.4.5 DL/Hybrid Approach

Combining predictive and adaptive elements to create a tailored development approach. Hybrid approaches acknowledge that few projects are purely predictive or purely adaptive.

Topics:

Core

- Rationale for hybrid approaches: mixing predictive stability with adaptive flexibility
- Common hybrid patterns: predictive planning with agile delivery, rolling wave with fixed milestones
- Governance challenges in hybrid approaches: reporting, metrics, and decision authority
- Managing the transition between predictive and adaptive phases within a hybrid life cycle

Learning Outcomes:

Core:

1. Design a hybrid approach combining predictive and adaptive elements for a given project context [Usage]
2. Evaluate the governance implications of a hybrid development approach [Assessment]
3. Justify the selection of a hybrid approach over a purely predictive or purely adaptive alternative [Assessment]

D.4.6 DL/Project Phase Structure

Defining the phase structure of the project life cycle, including phase sequencing, gate reviews, and the relationship between phases and the development approach.

Topics:

Core

- Defining project phases: sequential, overlapping, and iterative phase structures
- Phase gate reviews: decision criteria, governance, and go/no-go decisions
- Aligning phase structure with the selected development approach
- Defining exit criteria and deliverable acceptance standards for each project phase

Learning Outcomes:

Core:

1. Define an appropriate phase structure and gate review criteria for a given project [Usage]
2. Align the project phase structure with the selected development approach [Assessment]
3. Design a phase gate framework with clear entry and exit criteria appropriate to the project's risk profile [Assessment]

D.4.7 DL/Tailoring the Development Approach

Systematically tailoring the development approach and life cycle to the specific needs of the project. Tailoring is a deliberate, ongoing activity that balances organizational standards with project context.

Topics:

Core

- Tailoring process: assess context, select approach, customize, and continuously adjust
- Constraints on tailoring: regulatory requirements, organizational standards, and customer expectations
- Documenting tailoring decisions and rationale for governance and audit purposes
- Reviewing and refining tailoring decisions at project milestones based on performance evidence

Learning Outcomes:

Core:

1. Apply a tailoring process to customize the development approach for a specific project [Usage]
2. Justify tailoring decisions within organizational and regulatory constraints [Assessment]
3. Evaluate the effectiveness of tailoring decisions at project milestones and propose refinements [Assessment]

D.5 Planning (PL)

This performance domain covers the activities and functions associated with the initial, ongoing, and evolving organization and coordination necessary for delivering project outcomes. PMBoK 7th edition treats planning as an ongoing activity adapted to the development approach, not a one-time upfront exercise.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ D.5.1 Planning Principles (Pg.. 355)	1	1
⭐ D.5.2 Scope and Requirements Planning (Pg.. 355)	1	1
⭐ D.5.3 Schedule Planning (Pg.. 355)	1	1
⭐ D.5.4 Cost and Budget Planning (Pg.. 356)	1	1
D.5.5 Resource Planning (Pg.. 356)	Elective	
D.5.6 Quality Planning (Pg.. 356)	Elective	
D.5.7 Risk and Uncertainty Planning (Pg.. 357)	Elective	
D.5.8 Communications and Stakeholder Engagement Planning (Pg.. 357)	Elective	
D.5.9 Procurement Planning (Pg.. 357)	Elective	
D.5.10 Integrated Project Planning (Pg.. 358)	Elective	

Table D.5: List of KUs in the Planning area.

D.5.1 PL/Planning Principles (Core Tier1: 1 hr, Core Tier2: 1 hr)

Foundational principles for planning in PMBoK 7th edition: planning is iterative, just-enough, and adapted to the development approach and uncertainty level.

Topics:

Core

- Planning as an ongoing and iterative activity throughout the project life cycle
- Just-enough planning: balancing detail with flexibility based on uncertainty
- Relationship between planning depth and the selected development approach
- Adaptive planning: rolling wave, progressive elaboration, and iterative refinement

Learning Outcomes:

Core:

1. Describe the principles of iterative and just-enough planning in PMBoK 7th edition [Familiarity]
2. Apply adaptive planning principles to a project with high uncertainty and evolving requirements [Assessment]
3. Evaluate whether a project's planning approach provides sufficient detail and flexibility for its uncertainty level [Assessment]

D.5.2 PL/Scope and Requirements Planning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Defining and planning the scope of the project and product, including requirements elicitation, documentation, and traceability across all development approaches.

Topics:

Core

- Requirements elicitation techniques across predictive and adaptive approaches
- Scope definition: project scope statement vs. product backlog depending on approach
- Requirements traceability: linking requirements to outcomes across all approaches
- Scope decomposition: WBS for predictive, backlog structuring for adaptive

Learning Outcomes:

Core:

1. Define project and product scope using techniques appropriate to the selected development approach [Usage]
2. Compare scope planning approaches in predictive and adaptive development contexts [Assessment]
3. Design a requirements traceability approach ensuring all deliverables are linked to stated stakeholder needs [Assessment]

D.5.3 PL/Schedule Planning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Estimating, sequencing, and scheduling project activities. Covers both traditional scheduling (CPM, Gantt) and adaptive scheduling (sprint planning, release planning).

Topics:

Core

- Activity estimation techniques: analogous, parametric, three-point, and story points
- Schedule development: critical path for predictive, sprint and release planning for adaptive
- Building schedule flexibility: buffers, contingency, and iteration capacity
- Schedule baseline in predictive vs. release roadmap in adaptive: comparison and use

Learning Outcomes:

Core:

1. Develop a project schedule appropriate to the selected development approach [Usage]
2. Compare scheduling practices in predictive and adaptive project environments [Assessment]
3. Evaluate a project schedule for realism, buffer adequacy, and alignment with scope and resource constraints [Assessment]

D.5.4 PL/Cost and Budget Planning (Core Tier1: 1 hr, Core Tier2: 1 hr)

Estimating costs and establishing the project budget. Covers cost estimation techniques, budget structures, and contingency across development approaches.

Topics:

Core

- Cost estimation techniques: analogous, parametric, bottom-up, and three-point
- Budget structure: cost baseline, contingency reserves, and management reserves
- Cost planning in adaptive environments: fixed-capacity budgeting and cost per iteration
- Establishing and maintaining the cost performance baseline and managing reserve drawdown

Learning Outcomes:

Core:

1. Estimate project costs and develop a budget using appropriate techniques [Usage]
2. Adapt cost planning practices for adaptive and hybrid project environments [Assessment]
3. Evaluate the adequacy of a project budget including contingency and management reserves [Assessment]

D.5.5 PL/Resource Planning

Identifying, estimating, and planning for the human and physical resources needed to deliver project outcomes.

Topics:

Core

- Identifying required roles, skills, and physical resources for project delivery
- Resource estimation: effort estimation, capacity planning, and resource calendars
- Managing resource constraints: availability gaps, skill shortages, and procurement needs
- Resource leveling and smoothing: optimizing resource allocation across the project schedule

Learning Outcomes:

Core:

1. Develop a resource plan identifying required roles, skills, and quantities for project delivery [Usage]
2. Identify and resolve resource constraint issues in a project plan [Assessment]
3. Optimize resource allocation across the project schedule using leveling and smoothing techniques [Assessment]

D.5.6 PL/Quality Planning

Defining quality standards, metrics, and approaches for ensuring that project deliverables meet stakeholder expectations across all development approaches.

Topics:

Core

- Selecting applicable quality standards and metrics for the project and product
- Quality approach: testing strategy, definition of done, and acceptance criteria
- Quality planning in adaptive environments: continuous testing, automated QA, and done criteria
- Cost of conformance vs. cost of non-conformance: planning the right investment in quality

Learning Outcomes:

Core:

1. Define quality standards and acceptance criteria for a project's deliverables [Usage]
2. Design a quality approach appropriate for an adaptive or hybrid project environment [Assessment]
3. Evaluate the trade-off between quality investment and the risk of non-conformance in a project context [Assessment]

D.5.7 PL/Risk and Uncertainty Planning

Planning for risks and uncertainty as an integral part of the overall project plan. Covers risk identification, response planning, and uncertainty management across development approaches.

Topics:

Core

- Risk planning process: identification, qualitative assessment, response planning, and monitoring
- Planning for uncertainty: contingency reserves, timeboxes, and spike solutions
- Risk planning in adaptive environments: risk-adjusted backlog prioritization and iterative risk review
- Maintaining and updating the risk register throughout the project life cycle

Learning Outcomes:

Core:

1. Develop a risk management plan with identified risks and planned responses [Usage]
2. Adapt risk planning practices for adaptive project environments [Assessment]
3. Evaluate the comprehensiveness and adequacy of a risk management plan for a given project context [Assessment]

D.5.8 PL/Communications and Stakeholder Engagement Planning

Planning how information will flow to and from stakeholders throughout the project. Integrates communications and stakeholder engagement into a coherent plan.

Topics:

Core

- Communications plan: information needs, methods, frequency, and responsible parties
- Integrating stakeholder engagement strategies with the communications plan
- Information radiators and visual management tools for transparent project communication
- Communication channel analysis: determining the right medium, frequency, and audience for each communication

Learning Outcomes:

Core:

1. Develop an integrated communications and stakeholder engagement plan [Usage]
2. Implement information radiators and visual management practices for project transparency [Usage]
3. Design a communications plan that addresses the specific needs of diverse stakeholder groups across the project life cycle [Assessment]

D.5.9 PL/Procurement Planning

Planning for the acquisition of external products, services, or results. Covers make-or-buy decisions, contract type selection, and procurement strategy.

Topics:

Core

- Make-or-buy analysis: determining what to acquire externally and why
- Procurement strategy: contract types, vendor selection approach, and risk allocation
- Procurement considerations in adaptive projects: flexible contracts and vendor collaboration
- Vendor selection criteria: capability, cost, reliability, risk, and strategic fit

Learning Outcomes:

Core:

1. Develop a procurement plan including make-or-buy analysis and contract type selection [Usage]
2. Adapt procurement planning practices for adaptive and hybrid development contexts [Assessment]
3. Evaluate vendor proposals against defined selection criteria to support procurement decision-making [Assessment]

D.5.10 PL/Integrated Project Planning

Bringing together all planning elements into a coherent, integrated project plan. Covers the relationship between plan components, baselines, and the project management plan as a living document.
Topics:
Core

- Integrating subsidiary plans into a coherent project management plan
- The project plan as a living document: ongoing updates and rebaselines
- Baseline management: establishing, maintaining, and updating project baselines
- Differences in integrated planning artifacts across predictive, adaptive, and hybrid approaches

Learning Outcomes:
Core:

1. Develop an integrated project management plan combining all planning elements [Usage]
2. Compare integrated planning artifacts across predictive, adaptive, and hybrid approaches [Assessment]
3. Evaluate the internal consistency of an integrated project plan and identify gaps or conflicts among its subsidiary components [Assessment]

D.6 Project Work (PW)

This performance domain covers the activities and functions associated with establishing project processes, managing physical resources, and fostering a learning environment. It encompasses the day-to-day management of the work needed to keep the project progressing.

Knowledge Area (KA)	Core Tier1	Core Tier2
D.6.1 Managing Project Artifacts (Pg.. 358)	Elective	
D.6.2 Communication and Knowledge Management (Pg.. 359)	Elective	
D.6.3 Team Engagement During Execution (Pg.. 359)	Elective	
D.6.4 Stakeholder Engagement During Execution (Pg.. 359)	Elective	
D.6.5 Managing Physical Resources (Pg.. 360)	Elective	
D.6.6 Working with Procurements (Pg.. 360)	Elective	
D.6.7 Monitoring and Adapting Work (Pg.. 360)	Elective	

Table D.6: List of KUs in the Project Work area.

D.6.1 PW/Managing Project Artifacts

Creating, maintaining, and controlling project artifacts throughout the project life cycle. Covers configuration management, version control, and artifact accessibility.
Topics:
Core

- Project artifact types: plans, logs, registers, reports, agreements, and deliverables
- Configuration management: version control, change tracking, and artifact integrity
- Ensuring artifact accessibility and traceability across the project team and stakeholders
- Artifact retention and archiving policies aligned with organizational and regulatory requirements

Learning Outcomes:
Core:

1. Apply configuration management practices to maintain project artifact integrity [Usage]
2. Design an artifact management approach ensuring accessibility and traceability [Assessment]
3. Evaluate the artifact management system of a project for completeness, version control, and compliance [Assessment]

D.6.2 PW/Communication and Knowledge Management

Managing information flow and organizational knowledge during project execution. Covers lessons learned, knowledge transfer, and information distribution.

Topics:

Core

- Distributing project information to stakeholders according to the communications plan
- Capturing and sharing project knowledge: lessons learned, retrospectives, and knowledge repositories
- Contributing to organizational learning through systematic knowledge transfer
- Identifying and overcoming communication barriers: noise, filtering, cultural differences, and information overload

Learning Outcomes:

Core:

1. Execute the communications plan to distribute information effectively to project stakeholders [Usage]
2. Design a knowledge management approach that supports organizational learning throughout the project [Assessment]
3. Evaluate the effectiveness of project communication and identify improvements to reduce barriers and information gaps [Assessment]

D.6.3 PW/Team Engagement During Execution

Keeping the team engaged, motivated, and productive during project execution. Covers daily management practices, performance feedback, and maintaining team well-being.

Topics:

Core

- Daily management practices: stand-ups, task boards, and flow management
- Providing timely, constructive performance feedback to team members
- Monitoring and maintaining team well-being and sustainable pace
- Identifying and removing impediments that block team productivity and flow

Learning Outcomes:

Core:

1. Apply daily management practices to maintain team focus and productivity during execution [Usage]
2. Monitor team well-being indicators and take corrective action to maintain sustainable performance [Assessment]
3. Design an impediment management process that rapidly surfaces and resolves blockers during project execution [Assessment]

D.6.4 PW/Stakeholder Engagement During Execution

Actively engaging stakeholders during project execution to maintain alignment, address issues, and incorporate feedback into the work.

Topics:

Core

- Maintaining ongoing stakeholder engagement: check-ins, demos, and feedback loops
- Identifying, logging, and resolving stakeholder issues during execution
- Handling stakeholder-driven change requests during execution
- Tracking stakeholder satisfaction levels during execution and responding to declining engagement

Learning Outcomes:

Core:

1. Maintain active stakeholder engagement through regular touchpoints and feedback mechanisms [Usage]
2. Manage stakeholder-driven changes during execution while protecting project value delivery [Assessment]

3. Evaluate the effectiveness of stakeholder engagement during execution and recommend adjustments to the engagement approach [Assessment]

D.6.5 PW/Managing Physical Resources

Managing the physical resources required for project execution, including materials, equipment, facilities, and infrastructure.

Topics:

Core

- Acquiring and mobilizing physical resources according to the resource plan
- Monitoring physical resource utilization and addressing shortages or waste
- Optimizing physical resource usage to minimize cost and environmental impact
- Documenting physical resource usage, issues, and handover for audit and lessons learned

Learning Outcomes:

Core:

1. Monitor physical resource utilization and take corrective action for deviations [Usage]
2. Optimize physical resource management to reduce waste and improve efficiency [Assessment]
3. Design a physical resource management plan that addresses acquisition, utilization tracking, and responsible disposal [Assessment]

D.6.6 PW/Working with Procurements

Managing procurement activities during project execution, including vendor management, contract administration, and procurement performance monitoring.

Topics:

Core

- Day-to-day vendor management: communication, performance tracking, and issue resolution
- Contract administration during execution: change orders, compliance monitoring, and payments
- Building collaborative vendor relationships to support project value delivery
- Procurement closeout: final acceptance, release of obligations, and vendor performance assessment

Learning Outcomes:

Core:

1. Manage vendor performance and contract compliance during project execution [Usage]
2. Build a collaborative vendor relationship strategy that supports project outcomes [Assessment]
3. Evaluate vendor performance against contractual obligations and determine appropriate corrective or closeout actions [Assessment]

D.6.7 PW/Monitoring and Adapting Work

Continuously monitoring project work and adapting plans, priorities, and processes in response to performance data, emerging risks, and changing conditions.

Topics:

Core

- Monitoring work performance: progress tracking, burndown/burnup charts, and status reports
- Adapting work plans and priorities in response to performance data and new information
- Embedding continuous improvement practices: retrospectives, process reviews, and kaizen
- Distinguishing corrective actions (address current deviations) from preventive actions (avoid future issues)

Learning Outcomes:

Core:

1. Monitor project work progress and identify deviations requiring corrective action [Usage]
2. Implement continuous improvement practices to increase team and process effectiveness [Assessment]

3. Evaluate the adequacy of corrective and adaptive actions taken in response to project performance deviations [Assessment]

D.7 Delivery (DV)

This performance domain covers the activities and functions associated with delivering project outcomes that produce intended value. Delivery is about more than completing scope - it is about ensuring that what is delivered actually realizes the expected benefits.

Knowledge Area (KA)	Core Tier1	Core Tier2
D.7.1 Value Definition and Delivery (Pg.. 361)	Elective	
D.7.2 Requirements and Scope Delivery (Pg.. 361)	Elective	
D.7.3 Quality Assurance and Delivery (Pg.. 362)	Elective	
D.7.4 Incremental and Iterative Delivery (Pg.. 362)	Elective	
D.7.5 Transition and Handover (Pg.. 362)	Elective	
D.7.6 Benefits Realization Management (Pg.. 363)	Elective	
D.7.7 Customer and User Satisfaction (Pg.. 363)	Elective	

Table D.7: List of KUs in the Delivery area.

D.7.1 DV/Value Definition and Delivery

Defining value clearly at the start and continuously ensuring that project outputs are aligned with delivering that value. Value may be financial, social, or experiential.

Topics:

Core

- Defining project value: financial return, social impact, customer satisfaction, and strategic advancement
- Continuously aligning deliverables with defined value throughout the project
- Prioritizing features and deliverables by value contribution
- Validating delivered value with stakeholders and customers throughout the project

Learning Outcomes:

Core:

1. Define project value in terms meaningful to key stakeholders and align deliverables accordingly [Usage]
2. Prioritize project deliverables based on their relative value contribution [Assessment]
3. Evaluate whether delivered project outputs have achieved the defined value and propose corrective actions if gaps exist [Assessment]

D.7.2 DV/Requirements and Scope Delivery

Ensuring project deliverables meet defined requirements and scope, and that scope is managed to protect value delivery.

Topics:

Core

- Verifying that deliverables meet defined requirements and acceptance criteria
- Controlling scope to prevent scope creep and protect value delivery
- Making trade-off decisions between scope and value when constraints emerge
- Formal scope validation with stakeholders: reviews, sign-offs, and acceptance documentation

Learning Outcomes:

Core:

1. Verify project deliverables against requirements and acceptance criteria [Usage]
2. Make principled scope trade-off decisions to protect project value delivery [Assessment]
3. Design a scope validation process that ensures stakeholder acceptance at each delivery milestone [Assessment]

D.7.3 DV/Quality Assurance and Delivery

Ensuring deliverables meet quality standards through ongoing quality assurance and control activities embedded in the delivery process.

Topics:

Core

- Embedding quality into the delivery process: definition of done, acceptance criteria, and continuous testing
- Defect prevention strategies: root cause analysis, process improvement, and shift-left testing
- Tracking quality metrics across deliverables to detect trends and drive improvement
- Quality audits: reviewing adherence to quality processes and identifying systemic improvement opportunities

Learning Outcomes:

Core:

1. Apply quality assurance practices to ensure deliverables meet defined quality standards [Usage]
2. Analyze delivery quality metrics to identify improvement opportunities [Assessment]
3. Design a quality audit framework that continuously validates process adherence and delivery quality [Assessment]

D.7.4 DV/Incremental and Iterative Delivery

Delivering value in increments or iterations to provide early benefits, incorporate feedback, and reduce risk. Covers sprint reviews, minimum viable products, and release planning.

Topics:

Core

- Incremental delivery: releasing usable portions of the product to provide early value
- Iterative delivery: refining and improving deliverables based on feedback across iterations
- Minimum viable product (MVP) and minimum viable feature (MVF) for early value delivery
- Release planning: scheduling increments for maximum business value

Learning Outcomes:

Core:

1. Plan and execute incremental and iterative deliveries to provide early and continuous value [Usage]
2. Design a release plan that maximizes business value across delivery increments [Assessment]
3. Evaluate the results of a delivery iteration and use feedback to adjust the scope and priorities for subsequent increments [Assessment]

D.7.5 DV/Transition and Handover

Managing the transition of project deliverables into operations or to end users. Covers readiness assessment, knowledge transfer, and organizational change support.

Topics:

Core

- Readiness assessment: evaluating organizational and user readiness to receive deliverables
- Knowledge transfer to operations: documentation, training, and support arrangements
- Supporting organizational change management during the handover phase
- Producing comprehensive handover documentation: user manuals, operational guides, and support agreements

Learning Outcomes:

Core:

1. Plan a transition and handover process ensuring operational readiness [Usage]
2. Design change management support activities to enable successful adoption of project deliverables [Assessment]
3. Evaluate organizational and user readiness for handover and identify actions needed to close readiness gaps [Assessment]

D.7.6 DV/Benefits Realization Management

Ensuring that the benefits identified in the business case are actually realized after project completion. Covers benefits tracking, ownership, and post-project review.

Topics:

Core

- Identifying and documenting expected benefits in the business case and benefits register
- Assigning benefits ownership to operational stakeholders beyond project closure
- Tracking benefits realization post-project: metrics, timelines, and reporting
- Maintaining a benefits register linked to the business case throughout and after the project

Learning Outcomes:

Core:

1. Develop a benefits realization plan with defined metrics and ownership assignments [Usage]
2. Evaluate the extent to which project benefits have been realized after project completion [Assessment]
3. Design a post-project benefits tracking mechanism with clear ownership, timelines, and reporting thresholds [Assessment]

D.7.7 DV/Customer and User Satisfaction

Ensuring that project deliverables satisfy end users and customers. Covers user acceptance, satisfaction measurement, and feedback integration into delivery.

Topics:

Core

- User acceptance testing (UAT): validating deliverables with end users
- Measuring customer and user satisfaction: surveys, NPS, and feedback sessions
- Integrating customer and user feedback into ongoing delivery decisions
- Tracking satisfaction trends over time and using data to improve the delivery approach

Learning Outcomes:

Core:

1. Conduct user acceptance testing and document satisfaction outcomes [Usage]
2. Integrate customer feedback into delivery decisions to maximize user satisfaction [Assessment]
3. Evaluate customer and user satisfaction trends and propose delivery adjustments to close satisfaction gaps [Assessment]

D.8 Measurement (MS)

This performance domain covers the activities and functions associated with assessing project performance and taking appropriate actions to maintain acceptable performance. Measurement in PMBoK 7th edition goes beyond EVM to encompass a broader set of value-focused metrics.

Knowledge Area (KA)	Core Tier1	Core Tier2
⭐ D.8.1 Key Performance Indicators (Pg.. 363)	1	1
⭐ D.8.2 Dashboards and Information Radiators (Pg.. 364)	1	1
D.8.3 Measurement Purpose and Approach (Pg.. 364)	Elective	
D.8.4 Earned Value and Schedule Performance (Pg.. 364)	Elective	
D.8.5 Forecasting and Trends (Pg.. 365)	Elective	
D.8.6 Stakeholder Performance Reporting (Pg.. 365)	Elective	
D.8.7 Lessons Learned and Knowledge Capture (Pg.. 365)	Elective	

Table D.8: List of KUs in the Measurement area.

D.8.1 MS/Key Performance Indicators (Core Tier1: 1 hr, Core Tier2: 1 hr)

Defining, selecting, and using key performance indicators (KPIs) to track project health across scope, schedule, cost, quality, and value dimensions.

Topics:
Core
- Selecting KPIs: relevance to project objectives, measurability, and actionability
- Balanced metric sets: leading and lagging indicators, outcome and output metrics
- Setting KPI thresholds and alert levels for triggering corrective action
- Reviewing and adapting the KPI set as the project evolves and stakeholder priorities shift

Learning Outcomes:
Core:
1. Define a balanced KPI set for monitoring a project across multiple performance dimensions [Usage]
2. Evaluate a given set of KPIs for balance, relevance, and potential for metric dysfunction [Assessment]
3. Design a KPI review cycle that keeps performance metrics aligned with evolving project objectives [Assessment]

D.8.2 MS/Dashboards and Information Radiators (Core Tier1: 1 hr, Core Tier2: 1 hr)

Using visual management tools to make project performance visible to the team and stakeholders. Covers dashboards, kanban boards, burndown charts, and physical information radiators.

Topics:
Core
- Designing effective project dashboards: key metrics, visual clarity, and stakeholder relevance
- Information radiators: physical and digital tools for continuous team transparency
- Real-time dashboards: automated data feeds and live project status visualization
- Maintaining and evolving dashboards as the project progresses and information needs change

Learning Outcomes:
Core:
1. Design a project performance dashboard with relevant KPIs for team and stakeholder use [Usage]
2. Implement information radiators that provide real-time project transparency to the team [Assessment]
3. Evaluate the effectiveness of a dashboard in communicating project health and recommend improvements [Assessment]

D.8.3 MS/Measurement Purpose and Approach

Understanding why and how to measure project performance. Covers the purpose of measurement, the risk of metric dysfunction, and principles for selecting meaningful measures.

Topics:
Core
- Purpose of measurement: informing decisions, detecting issues, and demonstrating value
- Principles of effective measurement: meaningful, actionable, and timely metrics
- Metric dysfunction: gaming, Goodhart's Law, and the dangers of measuring the wrong things
- Selecting measurement approach based on project type, development approach, and stakeholder needs

Learning Outcomes:
Core:
1. Describe the purpose and principles of effective project performance measurement [Familiarity]
2. Identify the risk of metric dysfunction and select measures that drive the right behaviors [Usage]
3. Design a measurement approach appropriate to the project type and stakeholder needs [Assessment]

D.8.4 MS/Earned Value and Schedule Performance

Using Earned Value Management (EVM) and schedule performance indicators to measure project cost and schedule health. Covers EVM metrics, SPI, CPI, and forecasting.

Topics:
Core
- EVM metrics: PV, EV, AC, CV, SV, CPI, SPI
- EVM forecasting: EAC, ETC, VAC, and TCPI
- Applying earned value concepts in adaptive environments: velocity, burndown, and throughput
- Interpreting EVM trends over time to forecast project completion and identify systemic issues

Learning Outcomes:
Core:
1. Calculate and interpret EVM metrics to assess project cost and schedule performance [Usage]
2. Adapt EVM concepts for use in adaptive project environments [Assessment]
3. Use EVM data to forecast project completion cost and schedule and evaluate the accuracy of those forecasts [Assessment]

D.8.5 MS/Forecasting and Trends

Using current performance data to forecast future project outcomes. Covers trend analysis, forecasting techniques, and the use of forecasts for proactive management.
Topics:
Core
- Trend analysis: identifying performance patterns to predict future outcomes
- Forecasting techniques: EAC formulas, regression analysis, and expert judgment
- Using forecasts proactively to prevent problems rather than react to them
- Communicating forecast uncertainty: confidence intervals, scenario ranges, and assumptions

Learning Outcomes:
Core:
1. Apply trend analysis and forecasting techniques to predict project completion outcomes [Usage]
2. Use forecasting data to make proactive project management decisions [Assessment]
3. Evaluate the reliability of project forecasts by examining underlying assumptions and comparing against actual results [Assessment]

D.8.6 MS/Stakeholder Performance Reporting

Communicating project performance to stakeholders in a format and frequency appropriate to their needs. Covers report design, tailoring, and information transparency.
Topics:
Core
- Designing performance reports: content, format, and frequency tailored to stakeholder needs
- Transparent reporting: honest and complete performance communication including bad news
- Executive-level reporting: summarizing project health for senior stakeholders
- Exception reporting: focusing reporting effort on deviations, risks, and decisions rather than routine status

Learning Outcomes:
Core:
1. Prepare a project performance report tailored to a specific stakeholder audience [Usage]
2. Design an executive reporting structure that provides meaningful project health information [Assessment]
3. Evaluate a project reporting system for transparency, accuracy, and stakeholder relevance [Assessment]

D.8.7 MS/Lessons Learned and Knowledge Capture

Systematically capturing, documenting, and disseminating lessons learned throughout and after the project. Covers retrospectives, after-action reviews, and organizational knowledge assets.
Topics:
Core

- Lessons learned process: capture, analysis, documentation, and dissemination
- Retrospectives and after-action reviews: structured team reflection for continuous improvement

- Contributing lessons learned to organizational knowledge repositories and process assets
- Timing and frequency of lessons learned: ongoing capture vs. phase-end reviews vs. project closure

Learning Outcomes:
Core:

1. Conduct a lessons learned session and document findings for team and organizational use [Usage]
2. Integrate lessons learned into organizational knowledge assets to support future projects [Assessment]
3. Design a lessons learned program that captures insights continuously rather than only at project closure [Assessment]

D.9 Uncertainty (UN)

This performance domain covers the activities and functions associated with risk and uncertainty throughout the project. PMBoK 7th edition broadens the traditional risk focus to include ambiguity, complexity, and volatility as distinct forms of uncertainty requiring different management approaches.

Knowledge Area (KA)	Core Tier1	Core Tier2
D.9.1 Understanding Uncertainty and Risk (Pg.. 366)	Elective	
D.9.2 Risk Identification and Assessment (Pg.. 366)	Elective	
D.9.3 Threat and Opportunity Response (Pg.. 367)	Elective	
D.9.4 Ambiguity Management (Pg.. 367)	Elective	
D.9.5 Complexity Management (Pg.. 368)	Elective	
D.9.6 Volatility and Resilience Strategies (Pg.. 368)	Elective	
D.9.7 Monitoring and Adapting to Uncertainty (Pg.. 368)	Elective	

Table D.9: List of KUs in the Uncertainty area.

D.9.1 UN/Understanding Uncertainty and Risk

Distinguishing between uncertainty, risk, ambiguity, complexity, and volatility, and understanding how each requires different management strategies.
Topics:
Core

- Distinction between uncertainty (unknown probabilities) and risk (known probabilities and impacts)
- VUCA framework: volatility, uncertainty, complexity, and ambiguity in project environments
- Developing a balanced risk mindset: embracing opportunity while managing threats
- Assessing the uncertainty profile of a project: sources and types of uncertainty

Learning Outcomes:
Core:

1. Distinguish between risk, uncertainty, ambiguity, complexity, and volatility in project contexts [Familiarity]
2. Assess the uncertainty profile of a project and identify dominant uncertainty types [Assessment]
3. Select management strategies that are appropriate to the dominant type of uncertainty in a given project [Assessment]

D.9.2 UN/Risk Identification and Assessment

Identifying individual and overall project risks and assessing their probability, impact, and urgency using both qualitative and quantitative methods.

Topics:
Core

- Risk identification techniques: brainstorming, interviews, checklists, SWOT, and assumption analysis
- Qualitative risk assessment: probability-impact matrix and risk prioritization
- Quantitative risk assessment: EMV, Monte Carlo simulation, and sensitivity analysis
- Assessing overall project risk beyond individual risks: portfolio-level risk view and risk thresholds

Learning Outcomes:
Core:

1. Identify and prioritize project risks using qualitative assessment techniques [Usage]
2. Apply quantitative assessment techniques to measure overall project risk exposure [Assessment]
3. Evaluate the completeness of a risk register and recommend additional identification or assessment activities [Assessment]

D.9.3 UN/Threat and Opportunity Response

Planning and implementing responses to both threats and opportunities. PMBoK 7th emphasizes optimizing risk responses - not just mitigating threats but actively exploiting opportunities.
Topics:
Core

- Threat response strategies: avoid, transfer, mitigate, accept
- Opportunity response strategies: exploit, share, enhance, accept
- Optimizing responses: selecting cost-effective and proportional actions
- Managing residual and secondary risks created by responses

Learning Outcomes:
Core:

1. Select and justify risk response strategies for a set of prioritized threats and opportunities [Usage]
2. Evaluate the cost-effectiveness and secondary risk implications of planned responses [Assessment]
3. Design a balanced risk response plan that addresses both threats and opportunities proportionally [Assessment]

D.9.4 UN/Ambiguity Management

Managing ambiguity - situations where the problem or solution is unclear. Covers techniques for reducing ambiguity and making progress under unclear conditions.
Topics:
Core

- Types of ambiguity: conceptual (unclear problem), directional (unclear goal), temporal (unclear timing)
- Techniques for reducing ambiguity: experiments, prototypes, proof-of-concept, and stakeholder alignment
- Making progress under ambiguity: iterative discovery, timeboxing, and decision staging
- Assessing the ambiguity tolerance of the team and stakeholders and calibrating planning accordingly

Learning Outcomes:
Core:

1. Describe the different types of ambiguity and their impact on project planning [Familiarity]
2. Apply ambiguity reduction techniques to clarify project objectives and solution direction [Usage]
3. Design an approach for making productive progress when project goals or solutions remain unclear [Assessment]

D.9.5 UN/Complexity Management

Recognizing and navigating project complexity arising from system interdependencies, human behavior, and emergent dynamics. Covers complexity assessment and adaptive management strategies.
Topics:
Core

- Assessing project complexity: interdependency mapping, stakeholder diversity, and technical novelty
- Strategies for managing complexity: decomposition, incremental delivery, and expert facilitation
- Managing emergent behavior in complex projects: sense-and-respond and adaptive governance
- Ongoing monitoring of complexity indicators and escalating governance as complexity increases

Learning Outcomes:
Core:

1. Assess the complexity profile of a project and identify the primary complexity drivers [Usage]
2. Design adaptive management strategies for a project with high complexity [Assessment]
3. Evaluate the effectiveness of complexity management strategies and propose refinements as project conditions evolve [Assessment]

D.9.6 UN/Volatility and Resilience Strategies

Managing volatility - frequent and unpredictable changes in the project environment. Covers resilience-building strategies, rapid response capabilities, and organizational agility.
Topics:
Core

- Characteristics of volatile environments: rapid change, unpredictability, and short planning horizons
- Building project resilience: flexible planning, reserve capacity, and adaptive teams
- Rapid response mechanisms: decision escalation paths and pre-authorized response plans
- Early warning indicators of increasing volatility and triggers for activating resilience measures

Learning Outcomes:
Core:

1. Describe the characteristics of volatile project environments and their management challenges [Familiarity]
2. Apply resilience-building strategies to prepare a project team for high-volatility conditions [Usage]
3. Design rapid response mechanisms for a project operating in a volatile environment [Assessment]

D.9.7 UN/Monitoring and Adapting to Uncertainty

Continuously monitoring the uncertainty landscape and adapting project approach, plans, and responses as new information emerges throughout the project.
Topics:
Core

- Monitoring uncertainty: early warning indicators, trigger conditions, and horizon scanning
- Adapting plans and approaches in response to changing uncertainty conditions
- Learning and improving under uncertainty: experimental mindset and fast feedback loops
- Communicating uncertainty status to stakeholders: risk-adjusted forecasts and uncertainty heat maps

Learning Outcomes:
Core:

1. Monitor the uncertainty landscape using early warning indicators and trigger conditions [Usage]
2. Adapt project plans and approaches in response to emerging uncertainty [Usage]
3. Apply an experimental mindset and fast feedback loops to learn and improve under uncertainty [Assessment]