**National University of San Marcos Faculty of**

**Mathematical Sciences School of Scientific Computing**




# Book of short descriptions by course

*– 2026-I–*

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## 1.1 CS111. Introduction to Programming

This is the first course in the sequence of introductory courses to Computer Science. This course introduces participants to the fundamental concepts of programming using Python. Topics include data types, control structures, functions, lists, recursion, and the mechanics of execution, testing, and debugging. Programming is one of the pillars of Computer Science; any professional in the area will need to program to materialize their models and proposals.

This course includes the following topics: **1:** Introduction to Programming and History **2:** Type Systems Fundamentals **3:** Object-Oriented Programming Fundamentals **4:** Functions and Parameter Passing **5:** Basic Data Structures **6:** Object-Oriented Programming Fundamentals **7:** Algorithmic Strategies **8:** Modern Development Methods and Tool Usage

## 1.2 MA100. Basic Mathematics

The course includes knowledge of Notions of Propositional Logic and set theory, Real number systems, Integers, the Principle of Mathematical Induction, and polynomials of one variable. Matrices, determinants, and their applications in problems involving living beings. Introduction to statistics.

This course includes the following topics: **1:** Logic and Sets **2:** Number Systems **3:** Polynomials and Matrices **4:** Statistics and Probability

## 1.3 FG101. Language

The Language course is fundamental for the development of the university student's communicative skills. It focuses on mastering the rules and principles that regulate the use of standard Spanish, covering phonetic, syntactic, lexical, and pragmatic levels. Likewise, it seeks to strengthen the capacity for reading comprehension, synthesis, and academic writing under international standards, ensuring that the graduate can communicate their ideas with coherence, ethics, and academic rigor.

This course includes the following topics: **1:** Spanish Language and Regulations **2:** Academic Writing **3:** Text Drafting and Grammar **4:** Oral Expression and Public Speaking

## 1.4 FG105. Gender and Society

The Gender and Society course seeks to familiarize students with the category of gender as an analytical tool to understand social organization. The course critically addresses the implications of inequality and discrimination in the production of knowledge and in the socio-historical structure. Through this analysis, a reflective vision of the environment is promoted, fostering respect for diversity and the pursuit of equity in the exercise of citizenship and professional practice.

This course includes the following topics: **1:** Fundamental Concepts of Gender **2:** Gender, History, and Social Structure **3:** Gender, Power, and Citizenship **4:** Public Policies and Regulatory Framework

## 1.5 FG109. Environment and Sustainable Development

The Environment and Sustainable Development course is theoretical and practical in nature, aiming to raise student awareness regarding the importance of ecosystem conservation. The course covers the principles of ecology, the impact of human activities on the biosphere, and global strategies to achieve development that balances economic growth, social equity, and environmental protection. This knowledge is crucial for computer science professionals to design technological solutions with a focus on environmental responsibility and sustainability.

This course includes the following topics: **1:** Ecology and Biodiversity **2:** Environmental Impact and Climate Change **3:** Environmental Management and Regulations **4:** Strategies for Sustainable Development

## 1.6 FG112. Methods of managing university personnel

The course University Personal Management Methods is theoretical-practical in nature and aims to empower students through the development of intrapersonal competencies and intellectual work strategies. The course integrates self-knowledge and strategic planning processes with advanced learning techniques and digital tools. Through this comprehensive approach, students will be able to manage their behavior in the face of change, optimize their academic performance, and conduct research with ethical rigor, fostering a strategic vision to face the challenges of the contemporary university and professional environment.

This course includes the following topics: **1:** Strategic Management and Learning **2:** Intellectual Work Techniques and ICTs **3:** Leadership, Ethics, and Research **4:** Communication and Decision Making

## 1.7 FG140. Fundamentals of Scientific Research

The Fundamentals of Scientific Research course provides the student with the basic knowledge and tools for the development of high-quality scientific research. The course addresses the problematization of reality, theoretical foundation, methodology, and ethics in research. It seeks to develop in the student the capacity for critical observation, academic rigor, and intellectual honesty necessary to produce new knowledge that contributes to the advancement of science and technology.

This course includes the following topics: **1:** Science and Scientific Method **2:** Scientific Information Management **3:** Research Project Planning **4:** Scientific Writing and Communication

## 2.1 CS100. Introduction to Computer Science

This course serves as the foundation for understanding the fundamental concepts of computational thinking applicable across various professions.

The course provides, starting from ground zero, a panoramic view of: introductory computational thinking, data storage, computer architecture, operating systems, networks and the Internet, algorithms, sorting methods, software engineering, databases, data structures, software engineering, computer graphics, artificial intelligence among others.

Designed as an introductory course to Computer Science, the concepts are presented in a playful manner and using an Active Learning methodology. Throughout the course, active audience participation is encouraged, akin to a theatrical performance.

The related knowledge areas covered are directly aligned with the Computing Curricula ACM/IEEE-CS.

The course **does not require** any prior knowledge in computer handling topics and can be taken by student from any field.

This course includes the following topics: **1:** Computational Thinking (Part I) **2:** Computational Thinking. Part II **3:** General concepts **4:** Machine-Level Data Representation **5:** Program Abstraction and Representation **6:** Cryptography Fundamentals **7:** Memory Management **8:** Role and Purpose of Operating Systems **9:** Principles of Operating System **10:** Fundamentals of Networks and Communications **11:** Networked Applications **12:** Complexity Analysis Framework **13:** Asymptotic Notation and Complexity Classes **14:** Complexity Analysis: Recursion, Amortization, and Tight Bounds **15:** Foundational Data Structures **16:** Foundational Algorithms **17:** Advanced Algorithms **18:** Core Database System Concepts **19:** Object-Oriented Programming Fundamentals **20:** Version Control and CI/CD **21:** Requirements Engineering **22:** Machine Learning Fundamentals **23:** Neural Networks and Ethics **24:** Fundamental Concepts of Graphics and Interactive Techniques **25:** Applied Rendering and Techniques **26:** Closure Class: How Does a Search Engine Like Google Work?

## 2.2 CS112. Objects-oriented programming I

This is the second course in the introductory Computer Science programming sequence. It incorporates a programming language transition as a pedagogical strategy and focuses on core Object-Oriented Programming (OOP) concepts in C++17/C++20, expanding on the foundations from the first course while introducing low-level programming concepts. The course provides a solid foundation for advanced topics covered in the subsequent course of the curriculum.

This course includes the following topics: **1:** Language Pragmatics **2:** Language Translation and Execution **3:** Type Systems Fundamentals **4:** Object-Oriented Programming Fundamentals **5:** Systems Execution and Memory Model **6:** Functional Programming **7:** Object-Oriented Programming: Encapsulation, Subtyping, and Reflection **8:** Advanced Programming Constructs **9:** Shell Scripting

## 2.3 AI161. Applied AI

This course provides a practical introduction to Artificial Intelligence (AI) for students from all scientific and engineering disciplines. Focused on developing AI literacy and practical skills, it covers fundamental concepts, modern AI tools (including Western and Chinese platforms), and responsible usage. Students will learn to effectively interact with diverse AI systems, write quality prompts, and apply AI solutions to problems across various domains while understanding ethical implications and cultural contexts of AI deployment.

This course includes the following topics: **1:** AI Fundamentals and Global Landscape **2:** Effective AI Interaction and Cross-Platform Prompt Engineering **3:** AI Applications Across Disciplines and Platforms **4:** Global AI Ethics and Responsible Usage

## 2.4 MA111. Calculus I

The course includes knowledge of binary relations and real functions of a real variable. Limits, Continuity, and Derivatives of real functions, applications (maxima and minima), and Differentials applied to the solution of problems involving living beings.

This course includes the following topics: **1:** Computational Arithmetic and Error Analysis **2:** Roots Finding and Basic Numerical Optimization

## 2.5 FI101. General Physics

The course includes knowledge of the fundamental principles and laws of Physics, Newtonian Classical Mechanics, Kinematics, Statics, Dynamics, Energy and Work, conservative and non-conservative forces, Energy and Momentum. It emphasizes acoustic phenomena, electromagnetic waves, and optics with applications in biological sciences.

This course includes the following topics: **1:** Particle and Rigid Body Mechanics **2:** Work, Energy, and Momentum **3:** Fluid Mechanics and Thermodynamics **4:** Waves and Optics

## 3.1 CS113. Objects-oriented programming II

This is the third course in the sequence of introductory courses in computer science. This course explores advanced C++17/C++20 features focusing on high-performance systems development. Key topics include template metaprogramming, move semantics, perfect forwarding, RAII optimization, multiple/virtual inheritance patterns, concurrency with std::thread and async/await, lock-free programming, modern C++ paradigms such as CRTP and expression templates, and interfacing C++ with other languages. The course prepares students for game engines, high-performance computing, and embedded development where C++ dominates.

This course includes the following topics: **1:** Object-Oriented Programming: Encapsulation, Subtyping, and Reflection **2:** Type Systems: Polymorphism and Complementary Typing **3:** Memory Management **4:** Parallel and Distributed

Computing **5:** Advanced Programming Constructs **6:** Systems Execution and Memory Model **7:** Advanced Programming Constructs **8:** Advanced Programming Constructs **9:** Version Control and CI/CD

## 3.2 CS1D1. Discrete Structures I

Discrete structures are the backbone of computer science. This first course focuses on the fundamental logic and formal reasoning necessary to evaluate the correctness of computational processes. Students will master the formal language of mathematics to avoid ambiguity and will learn various proof techniques essential for the rigorous analysis of algorithms and software specifications.

This course includes the following topics: **1:** Discrete Mathematics **2:** Discrete Mathematics

## 3.3 CS2B1. Platform Based Development

Platform-based development focuses on the design and implementation of applications within specific computing environments. This course utilizes the Software Process and Design (SPD) framework to explore the unique constraints and capabilities of Web, Mobile, and Interactive platforms. Students will learn to apply shared architectural concerns and platform-specific APIs to build robust, scalable, and user-centric software solutions.

This course includes the following topics: **1:** Common Aspects: Platforms, APIs and Constraints **2:** Common Aspects: Platform Languages and Web Programming Patterns **3:** Frontend, Frameworks and Web Standards **4:** Mobile Platforms: Development Fundamentals **5:** Mobile Platforms: Architecture and Constraints **6:** Mobile Platforms: Capabilities and Asynchronous Computing **7:** SPD-SEP/Interactive **8:** Interactive Data and Analytics Platforms

## 3.4 MA112. Calculus II

The course includes knowledge of Integral Calculus: the Indefinite Integral (antiderivative). Integration Techniques. Definite Integral. Integration of hyperbolic and inverse functions. Applications of the Definite Integral (Areas of plane regions, Volumes, Length, Surface Area). Improper Integral. Applications in problems involving living beings.

This course includes the following topics: **1:** Numerical Differentiation and Integration **2:** Interpolation and Function Approximation

## 3.5 MA121. Linear Algebra I

This course introduces the fundamental concepts of linear algebra, providing the mathematical foundations for the study of vector spaces, linear transformations, and systems of linear equations. It develops abstract thinking and problem-solving skills through matrices, determinants, and vectors. The course is fundamental for applications in science, engineering, and computing.

This course includes the following topics: **1:** Numerical Linear Algebra **2:** Computational Arithmetic and Error Analysis **3:** Roots Finding and Basic Numerical Optimization **4:** Interpolation and Function Approximation

## 3.6 ID101. Technical and professional English I

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. It not only broadens its cultural horizon but also allows a more humane and comprehensive view of people's lives. In the case of foreign languages, English is undoubtedly the most pratical because it is spoken around the world. There is no country where it is not spoken. In careers related to tourist services English is perhaps the most important practical tool that the student must master from the outset as part of his comprehensive education.

This course includes the following topics: **1:** Hello everybody! **2:** Meeting people! **3:** The world of work **4:** Take it easy! **5:** Where do you live? **6:** Can you speak English? **7:** Then and now!

## 4.1 CS1D2. Discrete Structures II

Continuing from Discrete Structures I, this course explores more complex mathematical structures such as sets, relations, and functions, which are the basis for data modeling in databases and programming languages. Additionally, students will study counting techniques and recurrence relations, providing the analytical tools required to estimate the computational complexity of algorithms.

This course includes the following topics: **1:** Discrete Mathematics **2:** Discrete Mathematics

## 4.2 CS210. Algorithms and Data Structures

This course provides a comprehensive study of fundamental data structures and algorithms with emphasis on implementation using advanced C++ features. Building on prior C++ knowledge, students will implement generic data structures using templates and traits, ensuring type flexibility and performance. The course covers linear structures (vectors, various linked lists), tree structures (binary, AVL, B-trees), heaps, hash tables, tries, and concurrent data structures. Special focus is placed on modern C++ techniques including variadic templates for generic operations and concurrent programming for thread-safe data structures.

This course includes the following topics: **1:** Advanced Foundation for Data Structures **2:** Foundational Data Structures **3:** Foundational Data Structures **4:** Balanced and Multi-way Trees **5:** Foundational Data Structures **6:** Foundational Data Structures **7:** Concurrent Data Structures **8:** Specialized Structures and Applications

## 4.3 CS271. Data Management

This course introduces fundamental concepts and techniques in data management, focusing on relational database systems. Students will learn data modeling using entity-relationship diagrams, relational database design principles, normalization theory, and Structured Query Language (SQL). The course covers core database system components, transaction management, and basic query processing. Emphasis is placed on practical skills for designing, implementing, and querying databases, as well as understanding the role of data in organizations and the associated ethical considerations in data management.

This course includes the following topics: **1:** Core Database System Concepts **2:** Data Modeling **3:** Relational Databases **4:** Query Construction **5:** Query Construction **6:** Relational Databases **7:** DBMS Internals **8:** Data Security and Privacy

## 4.4 MA122. Linear Algebra II

This course deepens advanced concepts of linear algebra, focusing on inner product spaces, advanced linear transformations, matrix decompositions, and computational applications. It develops skills to analyze complex algebraic structures and apply matrix methods to problems in data science, signal processing, and optimization.

This course includes the following topics: **1:** Numerical Linear Algebra **2:** Computational Arithmetic and Error Analysis **3:** Interpolation and Function Approximation **4:** Numerical Methods for Ordinary Differential Equations (ODEs)

## 4.5 MA210. Calculus III

The nature of the course is theoretical-practical; its purpose is to develop a conceptual and methodological framework in students aimed at providing a solid mathematical foundation for understanding all natural phenomena. It includes the following thematic units: Differential calculus in several variables. Integral calculus in several variables. Vector calculus.

This course includes the following topics: **1:** Numerical Differentiation and Integration **2:** Numerical Methods for Ordinary Differential Equations (ODEs) **3:** Interpolation and Function Approximation **4:** Roots Finding and Basic Numerical Optimization

## 4.6 ID102. Technical and professional English II

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. It not only broadens its cultural horizon but also allows a more humane and comprehensive view of people's lives. In the case of foreign languages, English is undoubtedly the most practical because it is spoken around the world. There is no country where it is not spoken. In careers related to tourist services english

is perhaps the most important practical tool that the student must master from the outset as part of his comprehensive education.

This course includes the following topics: **1:** How long ago? **2:** Food you like! **3:** The world of work **4:** Looking good! **5:** Life is an adventure! **6:** You‘re pretty smart! **7:** Have you ever?

## 5.1 CS251. Computer graphics

Computer Graphics is a fundamental area of Computer Science that focuses on the mathematical and computational techniques for generating and manipulating images. This course provides students with the foundations of 2D and 3D modeling, rendering pipelines, and the physical principles of light and color, enabling them to develop high-performance visual applications, simulations, and interactive systems.

This course includes the following topics: **1:** Fundamental Concepts of Graphics and Interactive Techniques **2:** Applied Rendering and Techniques **3:** Geometric Modeling **4:** Visualization **5:** Shading and Advanced Rendering

## 5.2 MA211. Calculus IV

The nature of the course is theoretical-practical; its purpose is to develop a conceptual and methodological framework aimed at providing a solid mathematical foundation for understanding all natural phenomena. It includes the following thematic units: Sequences in $R^n$, $C$, $(R^m, R)$. Directional derivatives and implicit differentiation. Isometries of $R^n$, conics, and quadric surfaces. Vector fields.

This course includes the following topics: **1:** Numerical Differentiation and Integration **2:** Numerical Methods for Ordinary Differential Equations (ODEs) **3:** Interpolation and Function Approximation **4:** Roots Finding and Basic Numerical Optimization

## 5.3 MA221. Numerical Analysis I

This course introduces fundamental numerical methods for solving mathematical problems through computational algorithms. It develops skills for implementing and analyzing numerical methods in linear algebra, nonlinear equations, and interpolation, with emphasis on error analysis and numerical stability.

This course includes the following topics: **1:** Computational Arithmetic and Error Analysis **2:** Numerical Linear Algebra **3:** Roots Finding and Basic Numerical Optimization **4:** Interpolation and Function Approximation

## 5.4 MA222. Real Analysis I

The subject belongs to the area of Specific Studies; the nature of the course is theoretical-practical, and its purpose is oriented toward providing a solid mathematical foundation for understanding all natural phenomena. It includes the following thematic units: Countability. Sequences of real numbers. Topology

of $R$. Limit and continuity of real functions of a real variable. Derivation. Riemann-Stieltjes integral.

This course includes the following topics: **1:** Computational Arithmetic and Error Analysis **2:** Roots Finding and Basic Numerical Optimization **3:** Interpolation and Function Approximation **4:** Numerical Differentiation and Integration

## 5.5 MA251. Introduction to Statistics

Write justification for this course here ...

This course includes the following topics: **1:** Unit title

## 5.6 MA281. Numbers theory

Number Theory is a fundamental branch of pure mathematics that studies the properties of integers, serving as the foundation for numerous applications in computational mathematics, cryptography, and information theory. This course equips students with the theoretical and algorithmic tools to analyze problems of divisibility, primality, congruences, and Diophantine equations, developing rigorous logical-abstract thinking. The computational focus allows for the implementation and validation of theoretical concepts, laying the groundwork for areas such as public-key cryptography and factorization algorithms.

This course includes the following topics: **1:** Divisibility and Congruences **2:** Diophantine Equations and the Chinese Remainder Theorem **3:** Arithmetic Functions and Multiplicative Number Theory **4:** Quadratic Residues and Computational Applications

## 5.7 ID201. Technical and professional English III

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. It not only broadens its cultural horizon but also allows a more humane and comprehensive view of life. In the case of foreign languages, undoubtedly English is the most practical because it is spoken around the world. There is no country where it is not spoken. In careers related to tourist services, English is perhaps the most important practical tool that the student must master from the outset as part of his / her integral education

This course includes the following topics: **1:** Getting to know you! **2:** The way we live! **3:** It all went wrong! **4:** Let's go shopping! **5:** What do you want to do? **6:** The best in the world! **7:** Fame!

## 6.1 MA212. Ordinary Differential Equations

The Ordinary Differential Equations course provides the mathematical tools to analyze systems that evolve with respect to a single independent variable. It focuses on the modeling of dynamic systems through first-order equations, higher-order equations, and systems of equations, using both analytical and

numerical methods. It is fundamental for the understanding of mechanics, electrical circuits, and population models.

This course includes the following topics: **1:** First-Order Ordinary Differential Equations **2:** Higher-Order Differential Equations and Systems **3:** Numerical Methods for Differential Equations

## 6.2 MA325. Numerical Analysis II

This course advances the study of numerical methods for advanced mathematical problems, focusing on differential equations, numerical integration, and eigenvalue problems. It develops skills for implementing and analyzing sophisticated numerical algorithms with applications in engineering and computational sciences, with emphasis on stability and computational efficiency.

This course includes the following topics: **1:** Numerical Methods for Ordinary Differential Equations (ODEs) **2:** Numerical Differentiation and Integration **3:** Numerical Linear Algebra **4:** Interpolation and Function Approximation

## 6.3 MA351. Statistics and Probabilities

Probability and statistics provide the mathematical foundation for reasoning under uncertainty, analyzing data, and building predictive models – skills that are essential across computing, artificial intelligence, computational mathematics, and engineering alike. This course develops a rigorous understanding of probability theory and its use in describing random phenomena, together with the fundamentals of descriptive statistics, statistical inference (estimation, hypothesis testing, and Bayesian reasoning), and regression modeling, so that students can summarize and analyze data, quantify uncertainty, and draw sound quantitative conclusions in their own field of application.

This course includes the following topics: **1:** Numerical Summaries: Location, Spread, and Shape **2:** Sample Spaces and Events **3:** Probability Axioms and Properties **4:** Conditional Probability and Independence **5:** Discrete Random Variables and Distributions **6:** Continuous Random Variables and Distributions **7:** Joint, Marginal, and Conditional Distributions **8:** Limit Theorems: LLN and CLT **9:** Point Estimation **10:** Interval Estimation and Confidence Intervals **11:** Hypothesis Testing Foundations **12:** Bayesian Inference **13:** Simple Linear Regression

## 6.4 MA371. Functional analysis I

Functional analysis is a central pillar of modern mathematics, providing the framework to solve problems in differential equations, quantum mechanics, and numerical analysis. This course bridges the gap between linear algebra and infinite-dimensional spaces. By introducing Measure Theory as a rigorous foundation for integration, the course enables the study of Banach and Hilbert spaces, linear operators, and the fundamental theorems that govern functional systems.

This course includes the following topics: **1:** Measure and Integration **2:** Normed and Banach Spaces **3:** Hilbert Spaces **4:** Operator Theory and Spectral Theory

## 6.5 ID202. Technical and professional English IV

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. It not only broadens its cultural horizon but also allows a more humane and comprehensive view of life. In the case of foreign languages, English is undoubtedly the most practical because it is spoken around all the world. There is no country where it is not spoken. In addition to being vital to your professional career

This course includes the following topics: **1:** Do and don't! **2:** Going places! **3:** Scared to death! **4:** Things that changed the world! **5:** Dreams and reality! **6:** Making a living! **7:** All you need is love!

## 7.1 CS261. Artificial Intelligence

Artificial Intelligence (AI) is a fundamental field of computer science that seeks to create systems capable of performing tasks that typically require human intelligence. This course provides an introduction to the techniques used to build such systems, including search algorithms, probabilistic reasoning, and machine learning. Students will learn to model complex problems and implement intelligent agents, while considering the social and ethical implications of these technologies.

This course includes the following topics: **1:** Introduction to AI: Concepts and Intelligent Behavior **2:** Problem Characteristics and Agent Nature **3:** State and Uninformed Search **4:** Heuristic Search and CSP **5:** Adversarial Search and Stochastic Optimization **6:** Machine Learning Fundamentals **7:** Machine Learning Data, Representations and Evaluation **8:** Neural Networks and Ethics **9:** Machine Learning Formulation and Evaluation **10:** Deep Learning, RL and Ethics **11:** Knowledge Representation and Probabilistic Reasoning Foundations **12:** Independence, Markov Models and Decision Making **13:** AI Applications and Societal Impact **14:** Additional AI Applications and Societal Impact

## 7.2 CS3P1. Parallel and Distributed Computing

With the end of frequency scaling in single-core processors, parallel and distributed computing has become essential for high-performance software development. This course introduces students to the programming models, communication patterns, and coordination mechanisms required to exploit multi-core systems and distributed clusters. Students will learn to design scalable algorithms and evaluate their performance under different computational constraints.

This course includes the following topics: **1:** Programs: Declarative Parallelism **2:** Programs: Starting Activities **3:** Programs: Execution Properties **4:** Programs: Distribution **5:** Programs: Implementation Mappings **6:** GPU Programming **7:** Communication **8:** Communication: Properties and Extensions **9:** Memory and Consistency **10:** Coordination **11:** Coordination: Synchro-

nization and Atomicity **12:** Coordination: Advanced Properties **13:** Evaluation **14:** Evaluation: Formal Methods **15:** Evaluation: Testing and Measurement **16:** Algorithms **17:** Algorithms: Application Domains Survey **18:** Algorithms: Algorithmic Domains

## 7.3 MA213. Partial Differential Equations

The Partial Differential Equations course studies phenomena that depend on multiple variables, such as heat propagation, waves, and electrical potentials. The course introduces Fourier series and separation of variables methods to solve the classical equations of mathematical physics (Heat, Wave, and Laplace equations). It is a key component for advanced numerical simulation and continuum mechanics analysis.

This course includes the following topics: **1:** Fourier Series and Sturm-Liouville Problems **2:** Diffusion Equations (Heat) **3:** Wave and Laplace Equations **4:** Numerical Methods for PDE and Transforms

## 7.4 MA326. Numerical Analysis III

Numerical Analysis 3 focuses on the computational solution of Ordinary Differential Equations (ODEs). In computational mathematics, many systems cannot be solved analytically; therefore, understanding the convergence, stability, and efficiency of numerical integrators is vital. This course covers from basic one-step methods to advanced Runge-Kutta schemes and the specialized treatment of stiff equations, which are critical in simulating chemical reactions, electrical circuits, and structural mechanics.

This course includes the following topics: **1:** Numerical Solution of ODEs: Foundations **2:** Runge-Kutta Methods **3:** Linear Multi-step Methods **4:** Stiff Equations and Absolute Stability

## 7.5 MA361. Mathematical Modeling

This course introduces the fundamental principles of mathematical modeling to represent, analyze, and predict the behavior of systems in various areas such as science, engineering, and business. It emphasizes the formulation of models from real-world problems, their solution using mathematical and computational tools, and the critical interpretation of results. The course develops abstraction skills and the application of advanced mathematics to solve complex real-world problems.

This course includes the following topics: **1:** Mathematical Model Formulation **2:** Continuous Systems Simulation **3:** Discrete Systems Simulation **4:** Sensitivity Analysis and Robustness **5:** Model Validation and Verification

## 7.6 ID203. Technical and professional English V

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.

It not only broadens its cultural horizon but also allows a more humane and comprehensive view of life. In the case of foreign languages, undoubtedly English is the most practical because it is spoken around the world. There is no country where it is not spoken. In careers related to tourist services, English is perhaps the most important practical tool that the student must master from the outset as part of his / her integral education

This course includes the following topics: **1:** It's a wonderful world **2:** Happiness! **3:** Telling tales! **4:** Doing the right thing! **5:** On the move! **6:** I just love it!

## 8.1 AI263. Introduction to Machine Learning

This course introduces the fundamentals of machine learning, covering classical and modern algorithms for classification, regression, and clustering problems. It focuses on practical implementation using scikit-learn and TensorFlow, with applications in computer vision and natural language processing.

This course includes the following topics: **1:** ML Fundamentals **2:** Linear Models **3:** Ensembles and Trees **4:** Basic Neural Networks

## 8.2 MA401. Capstone Project I

This course represents the first semester of the capstone project in computational mathematics. Students develop an applied research project or technological development that integrates and applies the knowledge acquired during the degree program. The course emphasizes problem formulation, literature review, methodological design, and initial development of computational solutions under the supervision of a faculty advisor. Projects must demonstrate research capability, innovation, and application of computational mathematics to real-world problems.

This course includes the following topics: **1:** Project Formulation and Planning **2:** Methodological Development and Tools **3:** Implementation and Initial Development

## 8.3 CS2S1. Operating systems

The operating system is a collection of services needed to safely interface the hardware with applications. This course explores the mechanisms and policies needed to virtualize computation, memory, and I/O. Students will understand core concepts such as concurrency, persistence, and trust boundaries, which are fundamental for developing robust and efficient software systems.

This course includes the following topics: **1:** Role and Purpose of Operating Systems **2:** Shell Scripting **3:** Scheduling **4:** Memory Management **5:** File Systems API and Implementation **6:** Protection and Safety

## 8.4 CS3I1. Computer Security

In an increasingly digital world, security is no longer an optional feature but a fundamental requirement. This course provides a comprehensive introduction to the principles and practices of cybersecurity, covering everything from theoretical foundations to secure coding and digital forensics. Students will gain the skills necessary to design, implement, and govern secure systems while understanding the ethical and professional responsibilities involved in protecting information and infrastructure.

This course includes the following topics: **1:** Security Mindset and Principles **2:** Cryptography Fundamentals **3:** Injection and Input Validation **4:** Malware Analysis and Advanced Security **5:** Threat Analysis and Security Engineering **6:** Digital Forensics Techniques **7:** Security Governance, Management and Policy **8:** Security Ethics, Law and Society

## 8.5 QC251. Quantum Mechanics

Quantum mechanics is fundamental for understanding the physical principles that govern atomic and subatomic systems, which form the basis of modern computational technologies such as quantum computing, quantum cryptography, semiconductors, and solid-state devices. This course provides the mathematical and conceptual foundations of quantum mechanics, with special emphasis on its applications in computer science, including quantum algorithms, quantum simulation, and quantum hardware development.

This course includes the following topics: **1:** Fundamentals of Quantum Mechanics **2:** Simple Quantum Systems **3:** Linear Algebra in Quantum Mechanics **4:** Angular Momentum and Spin **5:** Perturbation Theory **6:** Applications in Quantum Computing

## 8.6 CS253. Exploratory data analysis

Exploratory Data Analysis (EDA) is a critical stage in any data science project. This course provides the tools to understand the structure, detect anomalies, and extract initial patterns from data before formal modeling. It focuses on the use of descriptive statistics, data cleaning, and preliminary visualization to validate assumptions and guide the selection of complex models, ensuring the integrity and quality of scientific findings.

This course includes the following topics: **1:** Foundations of Exploratory Data Analysis **2:** Data Cleaning and Preparation **3:** Univariate Descriptive Statistics **4:** Bivariate and Multivariate Exploration **5:** Computational Tools for Exploration **6:** Exploratory Hypothesis Testing **7:** Data Ethics and Responsibility **8:** Result Communication and Data Storytelling

## 8.7 CS370. Big Data and Analytics

In the current era, the volume, velocity, and variety of data exceed the capabilities of traditional storage and processing systems. This course introduces the fundamental concepts and technologies of Big Data. It covers distributed file

systems, parallel processing frameworks, NoSQL databases, and real-time data streaming. Students will learn to design scalable architectures to extract value from massive datasets.

This course includes the following topics: **1:** Core Database System Concepts **2:** Distributed Databases/Cloud Computing **3:** NoSQL Systems **4:** Data Analytics

## 8.8 STA252. Inferential Statistics

Inferential statistics is crucial in computer science for analyzing data, drawing conclusions, and making evidence-based decisions. This course covers the principles of statistical inference, including point estimation, confidence intervals, and hypothesis testing.

This course includes the following topics: **1:** Introduction to Statistical Inference **2:** Hypothesis Testing **3:** Analysis of Variance (ANOVA) **4:** Linear Regression **5:** Non-parametric Tests **6:** Applications in Computing

## 8.9 MA327. Numerical Analysis IV

Numerical Analysis 4 provides the computational tools necessary to solve Partial Differential Equations (PDEs), which describe a wide range of phenomena in physics, engineering, and finance. The course focuses on the three fundamental types of second-order PDEs: elliptic, parabolic, and hyperbolic. Students will learn to discretize continuous domains, analyze the stability and convergence of numerical schemes, and implement algorithms for complex boundary value problems.

This course includes the following topics: **1:** Elliptic Equations and Boundary Value Problems **2:** Parabolic Equations and Evolution Problems **3:** Hyperbolic Equations and Wave Phenomena **4:** Advanced Topics in Numerical PDEs

## 8.10 MA352. Stochastic processes

This course introduces the theory of stochastic processes, providing mathematical foundations for the study of systems that evolve randomly over time. It develops skills for modeling random phenomena in finance, engineering, and sciences through Markov chains, Poisson processes, and Brownian motion, with applications in simulation and analysis of stochastic systems.

This course includes the following topics: **1:** Advanced Probability and Stochastic Processes **2:** Discrete Systems Simulation **3:** Computational Statistical Inference **4:** Continuous Systems Simulation

## 8.11 MA372. Functional analysis II

This course deepens the theoretical foundations of measure and integration, providing essential tools for advanced analysis in infinite-dimensional spaces. It focuses on the rigorous construction of abstract measures and the operational

aspects of the Lebesgue integral. Finally, the course explores the geometric structure and operator theory in Hilbert spaces, which are fundamental for developing computational methods and models in mathematical physics.

This course includes the following topics: **1:** Measure Theory **2:** Integration Theory **3:** Hilbert Spaces **4:** Operator Theory

## 9.1 AI264. Deep Learning

This course covers modern deep learning fundamentals, including convolutional networks, transformer architectures, and training techniques for advanced AI systems.

This course includes the following topics: **1:** Neural Network Training and Optimization **2:** Regularization Techniques for Deep Networks **3:** Convolutional and Residual Network Architectures **4:** Transformer Architectures and Generative Models

## 9.2 MA402. Capstone Project II

This course constitutes the final phase of the capstone project in computational mathematics, where students complete, validate, and present an applied research project or technological development. It emphasizes the complete implementation of computational solutions, rigorous analysis of results, methodological validation, and professional communication of findings. The project must demonstrate mastery of computational mathematics, innovation capability, and contribution to knowledge or solution of real-world problems, culminating in professional-quality work and a public defense before a specialized jury.

This course includes the following topics: **1:** Advanced Implementation and Optimization **2:** Results Analysis and Validation **3:** Professional Documentation and Communication **4:** Defense and Final Evaluation

## 9.3 CS231. Networking and Communication

Networking and communication are foundational to modern computing systems, distributed applications, and the global internet. This course provides a comprehensive introduction to the full CS2023 Networking and Communication Body of Knowledge—from physical transmission and data link protocols, through reliable transport and routing, to application services, security, mobility, and emerging paradigms such as SDN and quantum networking. Students will develop both theoretical understanding and practical skills applicable to the design and analysis of modern networked systems.

This course includes the following topics: **1:** Fundamentals of Networks and Communications **2:** Single Hop Communication **3:** Networked Applications **4:** Reliability Support **5:** Routing and Forwarding **6:** Network Security **7:** Mobility Support **8:** Emerging Topics

## 9.4 MA381. Algebraic Structures

Algebraic Structures provides the formal and abstract foundation essential for advanced mathematics and its computational applications. This course introduces the fundamental structures of modern algebra—groups, rings, and fields—developing the ability to think in terms of axioms, homomorphisms, and invariants. Mastery of these concepts is crucial for understanding the theoretical underpinnings of areas such as coding theory, cryptography, algorithm design, and algebraic geometry. The course emphasizes the interplay between abstract theory and concrete examples, particularly those arising in computational and discrete mathematics.

This course includes the following topics: **1:** Groups and Subgroups **2:** Cosets, Normal Subgroups, and Homomorphisms **3:** Rings, Ideals, and Integral Domains **4:** Fields and Applications

## 9.5 AI262. Natural Language Processing

This course introduces the theoretical and practical fundamentals of Natural Language Processing (NLP), covering from classical techniques to modern deep learning models. Students will learn to implement complete NLP pipelines for applications like sentiment analysis, machine translation, and chatbots.

This course includes the following topics: **1:** NLP Fundamentals **2:** Language Modeling **3:** Transformers and Modern NLP **4:** Practical Applications

## 9.6 CS273. Time series analysis

In various fields such as finance, meteorology, and engineering, data is collected sequentially over time, presenting unique temporal dependencies. This course introduces the theoretical and practical foundations for analyzing, modeling, and forecasting time series. It covers everything from classical decomposition methods to advanced stochastic models (ARIMA, GARCH), allowing the student to extract relevant information from dynamic processes and make decisions based on rigorous predictions.

This course includes the following topics: **1:** Introduction and Fundamental Concepts **2:** Stationarity and Autocorrelation Functions **3:** Linear Process Models (AR and MA) **4:** Box-Jenkins Methodology and ARIMA Models **5:** Forecasting and Model Evaluation **6:** Volatility Models (ARCH and GARCH) **7:** Ethics and Responsibility in Forecasting **8:** Implementation and Real-World Applications

## 9.7 MA341. Optimization I

This course introduces the mathematical foundations of optimization, covering both unconstrained and constrained problems. Classical methods of continuous optimization, optimality conditions, numerical algorithms, and applications in various fields are studied. The course provides the theoretical and computational foundations for formulating and solving optimization problems in science,

engineering, and economics, developing analytical skills to characterize and find optimal solutions.

This course includes the following topics: **1:** Convex and Non-Convex Optimization **2:** Constrained Optimization **3:** Optimization for Machine Learning **4:** Metaheuristics and Bio-Inspired Optimization

## 9.8 MA355. Statistical Learning Theory

This course provides the theoretical foundations of statistical learning, covering the mathematical principles that support machine learning algorithms. It focuses on the theoretical analysis of generalization capability, model complexity, and performance guarantees for various learning methods. The course connects theory with practice through the study of generalization bounds, bias-variance tradeoff, and foundations of computational learning theory.

This course includes the following topics: **1:** Foundations of Statistical Learning **2:** Supervised Learning Methods **3:** Unsupervised Learning Methods **4:** Model Evaluation and Selection

## 10.1 CS400. Pre-professional internships

This course allows students to apply the knowledge acquired during their academic training in a real work environment, under the supervision of a company and the university. Pre-professional internships are essential to develop professional, ethical, and technical competencies, ensuring that the student gains experience in projects related to the degree program.

This course includes the following topics: **1:** Performance Evaluation in Work Environment

## 10.2 AI268. Computational Vision

Computer Vision is a key area of Artificial Intelligence that enables machines to interpret and understand the visual world. This course covers fundamental techniques for image processing, feature extraction, and object recognition. With the advent of deep learning, computer vision has become essential for autonomous vehicles, medical imaging, and augmented reality. Students will learn the mathematical foundations and algorithmic approaches to solve real-world visual perception problems.

This course includes the following topics: **1:** Introduction to AI: Concepts and Intelligent Behavior **2:** Problem Characteristics and Agent Nature **3:** Perception and Computer Vision **4:** Machine Learning Fundamentals **5:** Machine Learning Data, Representations and Evaluation **6:** Neural Networks and Ethics **7:** Machine Learning Formulation and Evaluation **8:** Deep Learning, RL and Ethics **9:** Perception and Computer Vision

## 10.3 AI367. Topics in Artificial Intelligence

Artificial Intelligence is a rapidly evolving field. This course explores advanced and contemporary topics that are currently shaping the industry and research. Focus is placed on Generative AI, Large Language Models (LLMs), and Advanced Reinforcement Learning. Students will analyze the architectures behind modern AI systems, such as Transformers, and discuss the technical and societal challenges of deploying autonomous intelligent agents at scale.

This course includes the following topics: **1:** Machine Learning Fundamentals **2:** Machine Learning Data, Representations and Evaluation **3:** Neural Networks and Ethics **4:** Machine Learning Formulation and Evaluation **5:** Deep Learning, RL and Ethics **6:** Natural Language Processing **7:** Machine Learning Fundamentals **8:** Machine Learning Data, Representations and Evaluation **9:** Neural Networks and Ethics **10:** AI Applications and Societal Impact **11:** Additional AI Applications and Societal Impact

## 10.4 MA403. Capstone Project III

The Undergraduate Thesis in Computational Mathematics (MA403) course is the culmination of the student's academic training and research process. This course focuses on the consolidation of the final thesis report, ensuring compliance with scientific standards and academic integrity. The student must demonstrate a total integration of mathematical knowledge and computational skills to solve a research problem, finalizing with the formal presentation of the manuscript and technical preparation for the defense before the academic and professional community.

This course includes the following topics: **1:** Technical Consolidation and Final Optimization **2:** Methodological Validation and Critical Analysis **3:** Academic Writing and Thesis Report **4:** Defense and Professional Projection

## 10.5 QC381. Introduction to Quantum Computing

This course introduces the fundamental principles of quantum computing, including qubits, superposition, entanglement, quantum algorithms, and hardware. Students will contrast classical and quantum models, exploring applications in cryptography, optimization, physical simulation, and quantum machine learning, using frameworks like Qiskit or Cirq. Includes a practical module on hardware architectures (superconductors, ion traps) and their impact on algorithm design.

This course includes the following topics: **1:** Foundational concepts **2:** Quantum Architectures **3:** Algorithmic Strategies **4:** Formal Languages and Automata **5:** Ethics and Post-Quantum Security

## 10.6 CS254. Advanced Data Visualization

In the Big Data era, the ability to communicate complex information visually and effectively is fundamental. This course delves into the principles of visual perception, interactive dashboard design, and the use of advanced tools

for data storytelling. It focuses on transforming abstract analysis into visual representations that facilitate strategic decision-making, integrating aesthetics, functionality, and ethics in information management.

This course includes the following topics: **1:** Visual Perception and Design Principles **2:** Interactive and Dynamic Visualization **3:** Spatial and Temporal Data Visualization **4:** Multivariate and High-Dimensional Data **5:** Dashboard Design and Business Intelligence **6:** Data Storytelling and Communication **7:** Ethics and Visual Deception **8:** Final Project: Visualization Portfolio