



National University of Engineering (UNI)

School of Civil Engineering
Syllabus 2026-II

1. COURSE

CE3H3. Water Supply and Sewerage (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE3H3. Water Supply and Sewerage
2.2 Semester	: 9 th Semester.
2.3 Credits	: 4
2.4 Hours	: 4 HT; 2 HP;
2.5 Duration of the period	: 16 weeks
2.6 Type of course	: Mandatory
2.7 Learning modality	: Face to face
2.8 Prerequisites	: CE3H1. Fluid Mechanics II. (8 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Water Supply and Sewerage is an integrative course that brings together knowledge from hydrology, hydraulics, geotechnics, materials science, environmental chemistry, statistics, optimization, and project management for the design of urban water supply and sanitation systems. The student applies this multidisciplinary foundation to demand projection, the design of distribution and sewer networks, water and wastewater treatment, and the evaluation of sustainability and environmental impact of these systems.

5. GOALS

- Apply principles of hydrology, fluid mechanics, and geotechnics to the design of water supply and sewerage systems.
- Design potable water distribution networks and sewerage systems, including the selection of materials and associated hydraulic structures.
- Apply statistical, optimization, and graph theory tools to network sizing and layout.
- Evaluate the sustainability, environmental impact, and economic feasibility of water and sanitation projects.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

ABET-2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (Usage)

ABET-6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Usage)

7. TOPICS

Unit 1: Hydrologic Cycle and Water Balance (2 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Hydrologic cycle and water balance concepts • Precipitation measurement and analysis • Evaporation and evapotranspiration estimation • Infiltration theory and rainfall-runoff processes	• Explain the hydrologic cycle and quantify water balance components [Familiarity] • Analyze precipitation data and develop depth-area-duration relationships [Assessment] • Estimate evaporation and evapotranspiration using empirical methods [Usage] • Apply infiltration models to estimate runoff from rainfall events [Assessment]
Readings : [CMM88]	

Unit 2: Surface Hydrology and Watershed Modeling (2 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Hydrograph analysis and unit hydrograph method • Watershed modeling and hydrologic simulation • Streamflow measurement and gauging techniques	• Derive unit hydrographs and synthesize runoff hydrographs [Usage] • Develop watershed models using software tools for hydrologic simulation [Usage] • Conduct streamflow measurements and interpret flow duration curves [Assessment]
Readings : [CMM88]	

Unit 3: Flood Frequency Analysis and Climate Change (2 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Flood frequency analysis and design storms • Hydrologic routing methods for channels and reservoirs • Climate change impacts on hydrologic systems	• Perform flood frequency analysis using statistical methods [Assessment] • Route flood hydrographs through channels and reservoirs [Usage] • Evaluate climate change impacts on watershed hydrology and design implications [Assessment]
Readings : [CMM88]	

Unit 4: Environmental Chemistry and Microbiology for Engineers (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Aquatic chemistry principles: acidity, alkalinity, hardness, and buffer capacity • Chemical equilibria and kinetics relevant to environmental processes • Microbial metabolism, growth, and classification in environmental contexts • Biogeochemical cycles of carbon, nitrogen, phosphorus, and sulfur • Water quality indicators and standard analytical methods • Colloid and surface chemistry for contaminant fate and transport • Toxicology and risk assessment of environmental contaminants • Molecular biology tools for environmental engineering applications • Fate and transport modeling of pollutants in engineered and natural systems	• Calculate pH, buffer intensity, and chemical speciation in aquatic systems [Usage] • Explain the role of key microbial groups in wastewater treatment and biogeochemical cycling [Familiarity] • Apply mass balance and reaction kinetics to environmental systems [Assessment] • Describe the major steps and environmental significance of the nitrogen and phosphorus cycles [Familiarity] • Interpret water quality data from standard analytical reports [Usage] • Analyze the role of colloidal and interfacial processes in contaminant removal [Assessment] • Define key toxicological parameters and concepts used in environmental risk assessment [Familiarity] • Evaluate the application of molecular techniques for monitoring engineered biological systems [Assessment] • Model the fate and transport of a conservative pollutant in a simple environmental compartment [Usage]
Readings : [DC10]	

Unit 5: Population Dynamics (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Exponential and logistic growth models; carrying capacity and the Allee effect • Lotka-Volterra predator-prey and competition models; equilibria and stability analysis • Age-structured models: Leslie matrices and the Euler-Lotka equation • Reaction-diffusion models and traveling waves in spatial ecology (Fisher-KPP equation) • Evolutionary dynamics: replicator equations, game theory, and the Price equation	• Analyze the stability of equilibria in Lotka-Volterra systems using linearization and phase portraits [Familiarity] • Construct age-structured population models using Leslie matrices and compute long-term growth rates [Usage] • Apply reaction-diffusion theory to model the spatial spread of an invasive species using the Fisher-KPP equation [Assessment]
Readings : [Edd+13]	

Unit 6: Mathematical Statistics and Estimation Theory (4 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Point estimation: Method of Moments and Maximum Likelihood Estimation • Construction and interpretation of confidence intervals in engineering tests • Hypothesis testing for engineering quality control and process validation • Linear and nonlinear regression for engineering data fitting • Introduction to Design of Experiments (DoE) for engineering optimization	• Derive Maximum Likelihood Estimators for parameters of engineering failure models [Usage] • Verify the statistical significance of engineering test results using hypothesis testing [Assessment] • Construct confidence intervals for key process parameters from experimental data [Usage] • Apply linear regression to model and predict engineering performance from measured data [Assessment]
Readings : [AT07]	

Unit 7: Interest Theory and Time Value of Money (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Compound interest: accumulation functions, effective and nominal rates, and force of interest • Annuities-immediate and annuities-due: present and accumulated values, perpetuities • Bond pricing: price-yield relationship, duration, convexity, and amortization schedules • Yield curves: spot rates, forward rates, and bootstrap methods for term structure • Portfolio immunization: Redington's conditions and cash-flow matching	• Compute the present value and accumulated value of annuities under various interest rate assumptions [Familiarity] • Price bonds using the price-yield relationship and calculate duration and convexity for interest rate sensitivity [Usage] • Construct a portfolio satisfying Redington's immunization conditions against parallel yield curve shifts [Assessment]
Readings : [BT17]	

Unit 8: Urban Water Systems (8 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Water demand estimation and distribution system design • Distribution network analysis and modeling • Water quality considerations in distribution systems • Stormwater runoff estimation using rational method • Storm sewer design and hydraulic analysis • Urban drainage best management practices • Advanced water distribution system modeling • Detention and retention facility design • Green infrastructure and low impact development • Combined sewer systems and overflow control	• Estimate water demands and design distribution system capacity [Assessment] • Analyze distribution networks for pressure and flow adequacy [Usage] • Address water quality issues including disinfection and corrosion [Familiarity] • Calculate stormwater runoff using the rational method [Assessment] • Design storm sewer systems following hydraulic grade line principles [Usage] • Implement stormwater best management practices for runoff control [Assessment] • Develop advanced water distribution models for system optimization [Usage] • Proportion detention and retention basins for peak flow reduction [Assessment] • Apply green infrastructure techniques for sustainable stormwater management [Usage] • Evaluate combined sewer overflow issues and design control measures [Assessment]
Readings : [Edd+13], [Whi16]	

Unit 9: Design of Hydraulic Structures (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Dam types and selection criteria • Spillway hydraulics and design • Weir and gate flow equations • Energy dissipation and stilling basin design • Culvert hydraulics and design • Dam safety analysis and risk assessment • Outlet works and control structures • Fish passage facilities and environmental hydraulics • Cavitation analysis and prevention • Physical hydraulic modeling and scale effects	• Classify dam types and select appropriate configurations for site conditions [Familiarity] • Design spillways for flood discharge capacity [Assessment] • Calculate discharge over weirs and through gates [Usage] • Proportion energy dissipation structures and stilling basins [Assessment] • Analyze culvert hydraulics for inlet and outlet control [Usage] • Perform dam safety evaluations and hazard classification [Assessment] • Design outlet works including intake structures and conduits [Usage] • Incorporate fish passage requirements in hydraulic structure design [Assessment] • Evaluate cavitation potential and design preventive measures [Usage] • Interpret physical model results and apply scale corrections [Assessment]
Readings : [Nov+07]	

Unit 10: Site Investigation and In-Situ Testing (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [Das19]	

Unit 11: Pressurized Pipe Flow and Pump Systems (6 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Pipe flow fundamentals and Darcy-Weisbach equation • Minor losses and pipe system analysis • Pipe network analysis methods • Pump characteristics and system curves • Pump selection and installation requirements • Water hammer and surge analysis • Pipeline design and material selection • Variable speed pumps and energy efficiency • Network modeling and optimization • Valve selection and hydraulic control systems	• Calculate head losses in pipe systems using friction equations [Assessment] • Determine total head loss including minor losses in complex piping [Usage] • Analyze pipe networks using Hardy Cross or equivalent methods [Assessment] • Construct pump characteristic curves and system head curves [Usage] • Select appropriate pumps based on operating point and efficiency [Assessment] • Evaluate water hammer effects and design surge protection [Usage] • Design pipelines considering hydraulic, structural, and economic factors [Assessment] • Apply variable speed drives for pump system optimization [Usage] • Optimize water distribution networks using modeling software [Assessment] • Specify valves and control systems for pipeline operations [Usage]
Readings : [Whi16], [Ávi02]	

Unit 12: Mechanics of Materials and Structural Behavior (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Stress and strain concepts including normal, shear, and principal stresses • Axial loading and deformation of members • Torsion of circular and non-circular sections • Bending stress and deflection in beams • Shear stress distribution in beams • Combined loading and stress transformation • Buckling of columns and stability analysis • Fatigue and fracture mechanics • Elastic and plastic behavior of materials • Energy methods for structural analysis	• Define stress, strain, and their relationships through constitutive laws [Familiarity] • Calculate stresses and deformations in members under axial loading [Usage] • Determine torsional stresses and angles of twist in shafts [Usage] • Analyze bending stress distribution and deflection in beams [Assessment] • Compute shear stress distribution in beam cross-sections [Usage] • Apply stress transformation equations for combined loading conditions [Assessment] • Evaluate column stability and calculate critical buckling loads [Assessment] • Explain fatigue failure mechanisms and predict fatigue life [Familiarity] • Distinguish between elastic and plastic material behavior under loading [Usage] • Use energy methods to solve deflection and indeterminate structural problems [Usage]
Readings : [Hib17]	

Unit 13: Standardized Testing, Quality Control, and Failure Analysis (4 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Standard test methods for material characterization and acceptance testing • Sampling procedures and representative sample selection • Quality control and quality assurance protocols in construction • Statistical analysis of test data and acceptance criteria • Non-destructive testing methods for materials and structures • Advanced material characterization techniques including microscopy and spectroscopy • Failure analysis methodology and root cause investigation • Forensic engineering and distress evaluation • Performance-based testing and specification approaches • Certification, compliance, and third-party testing requirements	• Perform standard material tests according to ASTM or equivalent specifications [Usage] • Develop appropriate sampling plans for construction material acceptance [Assessment] • Implement quality control procedures for construction materials and processes [Usage] • Analyze test data using statistical methods and establish acceptance criteria [Assessment] • Apply non-destructive testing techniques for in-situ material evaluation [Familiarity] • Utilize advanced characterization techniques to investigate material microstructure [Usage] • Conduct systematic failure analysis to determine root causes of material distress [Assessment] • Investigate structural failures using forensic engineering methodologies [Assessment] • Design performance-based test protocols for innovative materials [Usage] • Interpret certification requirements and coordinate third-party testing programs [Familiarity]
Readings : [Nev11]	

Unit 14: Construction Materials Science (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Physical and mechanical properties of construction materials including density, porosity, strength, and elasticity • Microstructure and phase composition of construction materials • Durability mechanisms including weathering, chemical attack, and environmental degradation • Thermal and moisture properties of construction materials • Crystalline and amorphous structures in construction materials • Material selection criteria based on performance requirements • Degradation mechanisms and service life prediction	• Describe the fundamental physical and mechanical properties of major construction materials [Familiarity] • Analyze the relationship between microstructure and macroscopic properties of materials [Assessment] • Evaluate the durability performance of materials under specific environmental conditions [Usage] • Explain the effects of thermal and moisture variations on material behavior [Familiarity] • Select appropriate construction materials based on design specifications and performance criteria [Assessment] • Predict service life and degradation patterns of materials in various environments [Usage]
Readings : [Nev11]	

Unit 15: Solid State and Material Chemistry (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Crystal systems, Bravais lattices, and Miller indices for engineering materials • X-ray diffraction for crystal structure determination and phase identification • Ionic compounds: crystal structures and lattice energies • Metallic and covalent network solids: bonding and engineering properties • Point defects, vacancies, interstitials, and non-stoichiometry in engineering solids • Band theory and the electronic properties of engineering conductors, semiconductors, and insulators • Synthesis methods for engineering inorganic materials: solid-state reactions, sol-gel, and CVD	• Identify crystal systems and describe symmetry operations in engineering solid materials [Familiarity] • Interpret X-ray diffraction patterns to identify crystal phases and determine unit cell parameters [Usage] • Calculate lattice energies using Born-Haber cycles for engineering ionic compounds [Usage] • Explain how point defects control diffusion, conductivity, and corrosion in engineering materials [Assessment] • Apply band theory to predict and engineer the electrical properties of solid materials [Assessment] • Select synthesis methods appropriate for producing specific engineering inorganic materials [Usage]
Readings : [CR20]	

Unit 16: Optimization Algorithms (4 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Gradient descent and line search methods: Armijo-Wolfe conditions and convergence rates • Newton's method and quasi-Newton methods (BFGS, L-BFGS) • Constrained optimization: KKT conditions, penalty methods, and sequential quadratic programming • Convex optimization algorithms: interior-point methods and the alternating direction method of multipliers (ADMM) • Stochastic gradient descent (SGD), variance reduction, and Adam optimizer	• Explain the convergence guarantees of gradient descent for smooth convex functions [Familiarity] • Apply Newton and quasi-Newton methods to unconstrained optimization problems [Usage] • Formulate a constrained optimization problem as a KKT system and apply an interior-point method [Assessment]
Readings : [NW06]	

Unit 17: Graph Theory (4 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Graphs: definitions, isomorphism, degree sequences, trees, and spanning trees • Connectivity, Menger's theorem, and network flows (max-flow min-cut) • Matchings (Hall's theorem), graph colorings, and the chromatic polynomial • Planar graphs, Euler's formula, Kuratowski's theorem, and the four-color theorem • Adjacency and Laplacian matrices, eigenvalues, and expander graphs	• Identify structural properties of graphs (connectivity, planarity, bipartiteness) and apply Euler's formula [Familiarity] • Apply Hall's marriage theorem and network flow algorithms to matching and routing problems [Usage] • Analyze a graph's spectrum to bound its chromatic number and connectivity properties [Assessment]
Readings : [Wes01]	

Unit 18: Climate Adaptation Engineering for Water Systems (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Climate science fundamentals and downscaling of global climate model projections • Hydrologic impacts of climate change: precipitation intensity, drought, and snowmelt • Vulnerability and risk assessment frameworks for water infrastructure • Water supply system adaptation: source diversification and demand management • Stormwater system adaptation for increased intensity rainfall • Coastal adaptation strategies: managed retreat, protective structures, and nature-based solutions • Decision-making under uncertainty and adaptive management pathways • Infrastructure design standards and codes under non-stationary climate conditions • Economic appraisal of adaptation options and financing mechanisms	• Interpret downscaled climate projections for key hydrologic variables [Familiarity] • Assess the vulnerability of a water supply system to projected changes in drought frequency [Assessment] • Redesign a stormwater culvert for increased design rainfall intensity based on climate projections [Usage] • Describe adaptation strategies for managing urban water demand under water scarcity [Familiarity] • Compare hard and soft (nature-based) engineering options for coastal flood protection [Assessment] • Develop an adaptive management plan for a reservoir facing uncertain future inflow regimes [Usage] • Propose revisions to infrastructure design standards to incorporate climate resilience [Assessment] • Conduct a cost-benefit analysis for a portfolio of water infrastructure adaptation measures [Usage]
Readings : [DC10]	

Unit 19: Open Channel Flow and River Mechanics (8 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Channel flow classification and hydraulic elements • Energy and momentum principles in open channels • Uniform flow and Manning's equation • Critical flow and specific energy concepts • Gradually varied flow profiles • Hydraulic jump and rapidly varied flow • Channel design for stable conveyance • Sediment transport in open channels • River morphology and channel stability • Scour analysis and protection measures	• Classify open channel flow regimes and calculate hydraulic elements [Familiarity] • Apply energy and momentum equations to solve channel flow problems [Assessment] • Calculate normal depth and discharge using Manning's equation [Usage] • Determine critical depth and analyze specific energy relationships [Assessment] • Compute gradually varied flow profiles using standard methods [Usage] • Analyze hydraulic jumps and calculate energy dissipation [Assessment] • Design stable channels with appropriate cross-sections and linings [Usage] • Estimate sediment transport rates in alluvial channels [Assessment] • Evaluate river channel stability and bank erosion potential [Familiarity] • Predict scour depths at hydraulic structures and design protection [Assessment]
Readings : [Cho59]	

Unit 20: Environmental Impact Assessment and Sustainability Metrics (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• EIA process: screening, scoping, impact analysis, mitigation, and public participation • Impact prediction methods for air, water, soil, noise, and ecological systems • Mitigation hierarchy and design of environmental management plans • Legal and institutional frameworks for EIA • Sustainability concepts and the triple bottom line (environment, economy, society) • Cumulative impact assessment and strategic environmental assessment (SEA) • Social impact assessment and stakeholder engagement methods • Sustainability metrics and indicator frameworks (e.g., SDGs, Envision) • Decision-support tools and multi-criteria analysis for sustainable design	• Outline the key stages of a standardized Environmental Impact Assessment (EIA) process [Familiarity] • Predict primary environmental impacts of a proposed infrastructure project on local air and water quality [Usage] • Develop mitigation measures for identified significant environmental impacts [Assessment] • Explain the legal requirements and purpose of EIA in the project approval process [Familiarity] • Apply the triple bottom line framework to evaluate a simple engineering project [Assessment] • Conduct a scoping exercise to define the boundaries and key issues for a cumulative impact assessment [Assessment] • Design a stakeholder engagement plan for a controversial development project [Usage] • Select appropriate sustainability metrics to track the performance of a green infrastructure project [Assessment] • Use a simple multi-criteria decision analysis (MCDA) tool to compare alternative project designs [Usage]
Readings : [GT19]	

Unit 21: Green Building Systems and Sustainable Urban Development (4 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• High-performance building envelopes and passive design strategies • Energy modeling, efficient HVAC systems, and on-site renewable generation • Water efficiency: low-flow fixtures, rainwater harvesting, and greywater reuse • Indoor environmental quality (IEQ): thermal comfort, daylighting, and air quality • Sustainable site design: stormwater management, heat island reduction, habitat preservation • Net-zero energy and water building design • Smart building technologies and IoT for operational optimization • Urban sustainability: transit-oriented development, density, and mixed-use planning • Green building certification systems: LEED, BREEAM, Living Building Challenge	• Design a building section illustrating key passive heating and cooling strategies [Assessment] • Size a rainwater harvesting system for a given roof area and demand [Usage] • Explain the key parameters affecting indoor air quality and thermal comfort [Familiarity] • Develop a site plan that minimizes impervious surfaces and incorporates green infrastructure [Usage] • Model a building's energy use to demonstrate a path to net-zero energy [Assessment] • Describe how a building automation system can optimize energy and water use [Familiarity] • Plan a transit-oriented development (TOD) node for reduced vehicle dependence [Assessment] • Prepare documentation for a project targeting a specific level of LEED certification [Usage]
Readings : [Kib16]	

Unit 22: Water and Wastewater Treatment Process Design (8 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Water quality parameters and regulatory standards for drinking water and wastewater effluent • Physical treatment processes: screening, sedimentation, flotation, and filtration • Chemical treatment processes: coagulation, flocculation, disinfection, and pH adjustment • Biological treatment principles: suspended growth (activated sludge) and attached growth (trickling filters) systems • Process selection and design criteria based on source water or wastewater characteristics • Advanced treatment processes: membrane filtration, advanced oxidation, and nutrient removal (N&P) • Sludge and biosolids handling, treatment, and disposal methods • Plant layout, hydraulic profile, and pumping system design • Industrial wastewater pretreatment and specific contaminant removal strategies • Process control, monitoring, and troubleshooting in treatment plants	• Identify key water quality parameters and their significance for human health and the environment [Familiarity] • Select appropriate physical and chemical unit processes for a given water or wastewater treatment objective [Assessment] • Design fundamental components of water treatment plants, such as rapid mix basins, flocculators, and sedimentation tanks [Usage] • Explain the biological mechanisms and operational parameters of activated sludge systems [Familiarity] • Size primary and secondary treatment units based on flow rates and pollutant loading [Assessment] • Design advanced treatment trains for water reuse or stringent nutrient discharge limits [Usage] • Evaluate sludge management alternatives and select appropriate thickening/dewatering methods [Assessment] • Develop hydraulic profiles and pump specifications for treatment plant layouts [Usage] • Propose pretreatment strategies for specific industrial wastewater streams [Assessment] • Implement basic process control strategies to optimize treatment plant performance [Usage]
Readings : [Edd+13]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

***** EVALUATION MISSING *****

10. BASIC BIBLIOGRAPHY

- [Cho59] Ven Te Chow. *Open-Channel Hydraulics*. McGraw-Hill, 1959.
- [CMM88] Ven Te Chow, David R. Maidment, and Larry W. Mays. *Applied Hydrology*. McGraw-Hill, 1988.
- [Wes01] Douglas B. West. *Introduction to Graph Theory*. 2nd. Prentice Hall, 2001.
- [Ávi02] Gilberto Sotelo Ávila. *Hidráulica General, Tomo I: Fundamentos*. 2da. Limusa, 2002.

- [NW06] Jorge Nocedal and Stephen J. Wright. *Numerical Optimization*. 2nd. Springer, 2006.
- [AT07] Alfredo H-S. Ang and Wilson H. Tang. *Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*. 2nd. Wiley, 2007.
- [Nov+07] Pavel Novak et al. *Hydraulic Structures*. 4th. Taylor & Francis, 2007.
- [DC10] Mackenzie L. Davis and David A. Cornwell. *Introduction to Environmental Engineering*. 5th. McGraw-Hill, 2010.
- [Nev11] A. M. Neville. *Properties of Concrete*. 5th. Pearson, 2011.
- [Edd+13] Metcalf & Eddy et al. *Wastewater Engineering: Treatment and Resource Recovery*. 5th. McGraw-Hill, 2013.
- [Kib16] Charles J. Kibert. *Sustainable Construction: Green Building Design and Delivery*. 5th. Wiley, 2016.
- [Whi16] Frank M. White. *Fluid Mechanics*. 8th. McGraw-Hill, 2016.
- [BT17] Leland Blank and Anthony Tarquin. *Engineering Economy*. 8th. McGraw-Hill, 2017.
- [Hib17] Russell Hibbeler. *Mechanics of Materials*. 10th. Pearson, 2017.
- [Das19] Braja M. Das. *Principles of Geotechnical Engineering*. 9th. Cengage Learning, 2019.
- [GT19] John Glasson and Riki Therivel. *Introduction to Environmental Impact Assessment*. 5th. Routledge, 2019.
- [CR20] William D. Callister and David G. Rethwisch. *Materials Science and Engineering: An Introduction*. 10th. Wiley, 2020.