MASTER IN WATER SCIENCES

Main Language of Instruction:
French ☑ English ○ Arabic ○

Campus Where the Program Is Offered: CST

OBJECTIVES

The management and renewal of water resources, along with maintaining their quality, efficient use, and the interplay between water and human health, are governed by a variety of mechanical, physico-chemical, or biological processes. These processes are crucial for managing the movement and quality of water and the substances it carries. In today's world, it's increasingly vital to possess a quantitative understanding of these processes to create advanced scientific tools. These tools are designed to forecast the future state of these resources at different spatial and temporal scales and to manage human impact on the hydrological cycle. Significant investments in both fundamental and applied research are essential and must be initiated. The Saint Joseph University of Beirut, recognizing the significance of these challenges, has established a Center focused on the scientific study of these issues. To support the research efforts of this Center, a postgraduate program has been introduced, offering a master's degree titled 'Water Sciences,' aimed at educating:

- Instructors and researchers.
- High-level experts, essential for various governmental departments and consulting firms.
- International researchers: Given the significance of the issues at hand, welcoming students from across the Mediterranean basin could foster a beneficial synergy for the collective management and utilization of water resources.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

The developed skills encompass the entire hydrological cycle, from understanding the physical and chemical processes to implementing water treatment methods. Students are trained to tackle complex challenges related to the sustainable management of water resources, both locally and internationally. Furthermore, research projects and mini-projects help to hone their ability to apply these skills in real-world contexts. At the end of the program, graduates are prepared to take on leadership roles as educators, researchers, specialists, and key contributors in administrations and design offices dedicated to the preservation and rational use of water resources.

ADMISSION REQUIREMENTS

Candidates are selected following the review of their application file:
Admission to the first semester of the Master's program (M1) is for graduates in Civil and Environmental Engineering or holders of a Bachelor in Water and Environment.

- Admission to the third semester of the Master's program (M3) is for graduates in Civil or Environmental Engineering, fifth-year civil engineering students at ESIB, and holders of an equivalent recognized diploma.

COURSES/CREDITS GRANTED BY EQUIVALENCE

Civil engineers graduating from ESIB, holders of a Master's or a Research Master's in water sciences, fifth-year civil engineering students at ESIB, and holders of an equivalent recognized diploma, validate by equivalence 60 credits of the program:
Hydraulics (6 Cr.). Hydrology (4 Cr.). Statistical Hydrology (4 Cr.). Measurement and Data Acquisition (4 Cr.). Water and Wastewater Treatment (4 Cr.). Solid Waste Management (4 Cr.). Mini Project 1 (4 Cr.). Strength of Materials (7 Cr.). Fluid Mechanics (7 Cr.). Soil and Rock Mechanics (8 Cr.). Finite Elements (4 Cr.). Mini Project 2 (4 Cr.).

PROGRAM REQUIREMENTS

This Master's program consists of 120 credits, distributed over 4 semesters MR1, MR2, MR3, and MR4, with generally 30 credits each. The Master's preparation includes:

- Theoretical and practical courses.
- Specialized seminars and conferences.
- Technical visits.
- A research internship in an approved center on a thesis topic.

Required courses (120 credits)
Spatial and Temporal Series Analysis (3 Cr.). Biogeochemistry (3 Cr.). Solid Waste Management (4 Cr.). Finite Elements (4 Cr.). Physico-Chemical Equilibria (3 Cr.). Water and Wastewater Treatment (4 Cr.). Water Management: Theory and Models. Water Resources. Urban Water (3 Cr.). Hydraulics (6 Cr.). Hydrology (4 Cr.). Physical Hydrology (3 Cr.). Statistical Hydrology (4 Cr.). Karst (3 Cr.). Underground Reservoirs (3 Cr.). Fluid Mechanics (7 Cr.). Soil and Rock Mechanics (8 Cr.). Measurement and Data Acquisition (4 Cr.). Mini Project 1 (4 Cr.). Mini Project 2 (4 Cr.). Advanced Processes for Wastewater Treatment (3 Cr.). Surface Water Quality (3 Cr.). Strength of Materials (7 Cr.). Research Internship with Thesis (30 Cr.). Climate Variability (3 Cr.).

SUGGESTED STUDY PLAN

Semester 1

Code	Course Name	Credits
020HYDMM1	Hydraulics	6
020HYOMM1	Hydrology	4
020HSTMM1	Statistical Hydrology	4
020ACQMM1	Measurement and Data Acquisition	4
020TRAMM1	Water and Wastewater Treatment	4
020DECMM1	Solid Waste Management	4
020SE1MM1	Mini-Project 1	4
	Total	**30**

Semester 2

Code	Course Name	Credits
020RDMMM2	Strength of Materials	7
020MEFMM2	Fluid Mechanics	7
020MESMM2	Soil and Rock Mechanics	8
020ELFMM2	Finite Elements	4
020SE2MM2	Mini-Project 2	4
	Total	**30**

Semester 3

Code	Course Name	Credits
020ASTMM3	Spatial and Temporal Series Analysis	3
020BGCMM3	Biogochemistry	3
020EPCMM3	Physico-Chemical Equilibria	3
020CFTMM3	Water Management: Theory and Models. Water Resources. Urban Water	3
020HYPMM3	Physical Hydrology	3

020KARMM3	Karst	3
020RESMM3	Underground Reservoirs	3
020TEUMM3	Advanced Processes for Wastewater Treatment	3
020QESMM3	Surface Water Quality	3
020VCLMM3	Climate Variability	3
	Total	**30**

Semester 4

Code	Course Name	Credits
020MSEMM4	Research Internship with Thesis	30
	Total	**30**

COURSE DESCRIPTION

020TEUMM3 Advanced Processes for Wastewater Treatment 3 Cr.

Topics covered include: Conventional wastewater treatment processes: Review - Sizing of conventional physicochemical treatment processes - Sizing of conventional biological treatment processes - Advanced physicochemical treatment processes. Advanced biological treatment processes (new anaerobic and aerobic membrane techniques). Tertiary treatment processes (case of industrial effluents). Techno-economic study of the installation of wastewater treatment units. Evaluation of the conditions, advantages, and constraints of installing wastewater treatment units. Research and case studies of cutting-edge technologies.

020BGCMM3 Biogeochemistry 3 Cr.

Topics covered include: Subterranean transfers. Isotopic tracing of natural waters. Major natural cycles (C, N, S, P, O)

020VCLMM3 Climate Variability 3 Cr.

Topics covered include: Climate variability, impact on hydrology.

020ACQMM1 Data Measurement and Acquisition 4 Cr.

Topics covered include: Equipment. Speed measurement at laboratory and industrial scales. Potable and hot water meters. Equipment for modern network management. Basics of sensors, remote transmission, and remote control. Surface hydrological measurements. Climatic stations, evaporation. Limnometry. Flow measurement. Calibration of a hydrometric station. Data acquisition and processing.

020ELFMM2 Finite Elements 4 Cr.

Topics covered include: Fundamentals of the finite element method. Variational formulation. Discretization. Assembly of elementary equations and global analysis. Numerical methods.

020MEFMM2 Fluid Mechanics 7 Cr.

Topics covered include: Concepts and properties of fluids. General principles of kinematics. Stress theory. Statics of incompressible and compressible fluids. Balance equations. Application to perfect fluids. Vortical kinematics. Potential plane flows. Flow regimes and application to laminar and turbulent flows. Introduction to the boundary layer. Dimensional analysis and similarity. Numerical approach. Practical Work (TP): Nozzles - Rheoelectric analogy flows. Poiseuille flows. Verification of Bernoulli's relation. Flow in a hydrodynamic tunnel. Viscosity. Analysis of jets on plates and study of flow regimes.

020HYDMM1 Hydraulics 6 Cr.

Topics covered include: Boundary layer. Head loss. Pressurized networks in steady and unsteady state. Turbopumps. Transient regime networks. Network protection. Basic concepts of turbines. Feasibility calculations. Open

channels. Numerical approach. Practical Work (TP): Turbopumps. Head loss. Flows in open channels. Transient flows under pressure. Permeability study.

020HYOMM1 Hydrology 4 Cr.

Topics covered include: Basic climatological phenomena. Energy independence in a building from solar contributions. Study elements for the establishment of a stormwater evacuation project.

020KARMM3 Karst 3 Cr.

Topics covered include: Karstification. Different hydrogeological conceptions of karst. Systemic approach applied to karst. Chemical and isotopic tracing. Exploitation and protection of karst water resources.

020SE1MM1 Mini Project 1 4 Cr.

Students will carry out a mini project in one of the courses of this semester.

020SE2MM2 Mini Project 2 4 Cr.

Students will carry out a mini project in one of the courses of this semester.

020HYPMM3 Physical Hydrology 3 Cr.

Topics covered include: Energy transfers. Precipitation. Infiltration. Runoff. Evapotranspiration. River flow.

020EPCMM3 Physicochemical Equilibria 3 Cr.

Topics covered include: Main chemical, physical, and biological processes that influence the physicochemistry of natural waters. Chemical equilibria in solution (acid-base reactions, carbonate chemistry, redox equilibria, precipitation-dissolution). Reactions at the solid-liquid interface as well as interactions with aquatic organisms. Chemistry.

020MSEMM4 Research Internship with Thesis 30 Cr.

This course serves as an introduction to research techniques. It is the synthesis of four months of research work in a research center or laboratory.

020MESMM2 Soil and Rock Mechanics 8 Cr.

Topics covered include: Generalities. Properties and classification of soils. Clay minerals. Compaction and road geotechnics. Water in soils. Permeability, flow, and effective stress. Consolidation and settlements. Consolidation rate. Mohr's circle and soil failure theories - Introduction to the mechanical properties of rocks. Environmental geotechnics. Practical Work (TP): Washed granulometric analysis - Sedimentometric granulometric analysis - Atterberg limits - Shear test - Proctor test - Oedometer test.

020DECMM1 Solid Waste 4 Cr.

Topics covered include: Urban waste. Collection. Cleaning of public roads. Treatment and recovery. Industrial and hospital waste. Waste recovery.

020ASTMM3 Spatial and Temporal Series Analysis 3 Cr.

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020HSTMM1 Statistical Hydrology 4 Cr.

Topics covered include: Statistical analysis of hydrological data. Graphical data representation. Extreme values of a variable. Correlative analysis. Simple and multiple regression. Statistical study of rainfall. Frequency analysis. IDF curves. Design rain. Example of a statistical model in hydrology.

020RDMMM2 Strength of Materials 7 Cr.

Topics covered include: Beam theory. Normal force. Bending. Torsion. Shear force. Calculation of the critical load of a structure: Euler's theory, Dutheil's theory. Energy theorems: Clapeyron, Maxwell-Betti Reciprocity, virtual work, Castigliano, Ménabréa. Three-moment method. Focal method. Section method. Elastic center method. Practical Work (TP): Compression test on concrete cylinder + ultrasound, extensometry, torsion, tensile test on metal bar.

020QESMM3 Surface Water Quality 3 Cr.

Topics covered include: Application of mathematical models to simulate the distribution and evolution of effluents discharged into lakes, reservoirs, rivers, estuaries, and oceans. Formulation of analytical models and simple numerical resolutions. Cycles of elements, such as oxygen, nitrogen, and phosphorus, as indicators of water quality. Salinity intrusion in estuaries. Eutrophication and sedimentation processes in lakes and reservoirs.

020RESMM3 Underground Reservoirs 3 Cr.

Topics covered include: Diffusivity equation. Consolidation - Permanent regime solutions of the diffusivity equation. Transient solutions of the diffusivity equation for flow tests. Mass and energy transport in porous media. Numerical solutions of flow and transport equations.

020CFTMM3 Water Management: Theory and Models, Water Resources, Water in the City 3 Cr.

Topics covered include: Principles, definitions, and implementation. Operational research. Linear and nonlinear programming. Dynamic and multicriteria programming. Simulation methods and tools for water resource allocation: competition and usage conflicts, technical and institutional modes of resource distribution. Agricultural water uses and water demand management: usage practices and efficiencies, technical, economic, and regulatory instruments for regulation. Management of treatment and purification networks and systems.

020TRAMM1 Water and Wastewater Treatment 4 Cr.

Topics covered include: Potable water treatment. Microscreening. Adsorption. Water fluoridation and defluoridation. Wastewater management. Pretreatment. Biological purification. Sludge removal. Coagulation. Sedimentation. Filtration. Membrane techniques in liquid media. Reverse osmosis. Ultrafiltration. Distillation. Absorption.