

MASTER IN STRUCTURES AND SOIL MECHANICS**Main Language of Instruction:**French ☒ English ☐ Arabic ☐**Campus Where The Program Is Offered:** CST**OBJECTIVES**

The Master in Structures and Soil Mechanics provides advanced scientific training in civil engineering. This training enables students to prepare a thesis in civil engineering.

The program covers key areas of civil engineering, including structural analysis, material behavior, construction reliability, geotechnical engineering, geology, soil mechanics and soil dynamics, plates and shells, finite element modeling and analysis, Eurocodes, seismic and dynamic analysis, structural mechanics, soil-structure interaction, and related topics.

This program enables students to become:

- Teachers and researchers.
- Highly qualified specialists for relevant government agencies and design offices.

Given the importance of the issues addressed, welcoming students from Mediterranean countries can foster synergies and promote the effective sharing of resources.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

Students will develop a set of skills that prepare them to address the complex challenges associated with the design, analysis, and optimization of structures and foundations:

- Advanced structural design: in-depth understanding of advanced structural design principles, including international standards and advanced calculation methodologies. This includes the design of complex structures.
- Soil analysis: ability to analyze soil properties, evaluate their behavior under different loads, and propose appropriate geotechnical solutions. This includes the modeling of soil-structure interaction and geotechnical risk assessment.
- Use of nonlinear analysis software: effective use of advanced modeling and simulation software.
- Project management: ability to manage the resources and expertise necessary to plan and execute a project.
- Communication techniques: ability to write detailed engineering reports, present results in a clear and concise manner, and work effectively in teams.

ADMISSION REQUIREMENTS

Candidates are selected based on a review of their application file.

- Admission to the first semester of the Master's program (M1) for candidates holding a Bachelor in Physics or an equivalent diploma.
- Admission to the third semester of the Master's program (M3) for:
 - Civil engineering graduates.
 - Holders of a Master's or Professional Master's degree in Physics.
 - Third-year civil engineering students at ESIB (fifth year of higher education).
 - Holders of a recognized equivalent degree.

The selection of candidates is made by an admissions committee, subject to the program's enrollment capacity.

COURSES/CREDITS GRANTED BY EQUIVALENCE

Civil engineering graduates, holders of a Master or professional Master in physics, fifth year civil engineering students at ESIB, and holders of a recognized equivalent diploma are granted 60 credits by equivalence:

Foundation Engineering (5 Cr.). Shear Strength and Slope Stability (4 Cr.). Plates and Shells (4 Cr.). Structures Plastic Behavior (4 Cr.). Structural Dynamics and Earthquake Engineering (4 Cr.). Dams (4 Cr.). Small Project I (5

Cr.). Strength of Materials (7 Cr.). Fluid Mechanics (7 Cr.). Soil and Rock Mechanics (8 Cr.). Structures (8 Cr.).

PROGRAM REQUIREMENTS

120 credits: Required courses (120 credits)

This program consists of 120 credits, divided into 4 semesters (M1, M2, M3, and M4) of around 30 credits each.

The program includes:

- Theoretical and practical lectures
- Specialized seminars and conferences
- Technical visits
- A research internship at an approved center, focusing on a thesis topic.

Required Courses (120 Cr.)

Foundation Engineering (5 Cr.). Shear Strength and Slope Stability (4 Cr.). Plates and Shells (4 Cr.). Structures Plastic Behavior (4 Cr.). Structural Dynamics and Earthquake Engineering (4 Cr.). Dams (4 Cr.). Small Project I (5 Cr.). Strength of Materials (7 Cr.). Fluid Mechanics (7 Cr.). Soil and Rock Mechanics (8 Cr.). Structures (8 Cr.). Behavior of Materials (3 Cr.). Calculation of Anelastic Structures (4 Cr.). Advanced Calculation of Concrete Structures (4 Cr.). Soil Dynamics (4 Cr.). Engineering Seismology (3 Cr.). Advanced Calculation of Steel Structures (3 Cr.). Advanced Statistics and Operational Research (3 Cr.). Design and Reliability of Structures (3 Cr.). Advanced Modeling of Materials and Structures (3 Cr.). Research Internship and Thesis (30 Cr.).

SUGGESTED STUDY PLAN

Semester 1

Code	Course Name	Credits
020FOSMM1	Foundation Engineering	5
020CISMM1	Shear Strength and Slope Stability	4
020PLCMM1	Plates and Shells	4
020PLSMM1	Structures Plastic Behavior	4
020DYNMM1	Structural Dynamics and Earthquake Engineering	4
020BARMM1	Dams	4
020SM1MM1	Small Project I	5
	Total	30

Semester 2

Code	Course Name	Credits
020RDMMM2	Strength of Materials	7
020MEFMM2	Fluid Mechanics	7
020MESMM2	Soil and Rock Mechanics	8
020STRMM2	Structures	8
	Total	30

Semester 3

Code	Course Name	Credits
020COMMM3	Behavior of Materials	3
020CSAMM3	Calculation of Anelastic Structures	4
020EC2MM3	Advanced Calculation of Concrete Structures	4
020DYSMM3	Soil Dynamics	4
020SISMM3	Engineering Seismology	3
020EC3MM3	Advanced Calculation of Steel Structures	3
020SROMM3	Advanced Statistics and Operational Research	3
020CFOMM3	Design and Reliability of Structures	3
020MMSMM3	Advanced Modeling of Materials and Structures	3
	Total	30

Semester 4

Code	Course Name	Credits
020MSMMM4	Research Internship and Thesis	30
	Total	30

COURSE DESCRIPTION

a- Semesters MR1 and MR2

020MEFMM2	Fluid Mechanics	7 Cr.
------------------	------------------------	--------------

This course covers the following: Concepts and properties of fluids. General principles of kinematics. Stress Theory. Statics of incompressible and compressible fluids. Conservation of mass and continuity equation. Application to the case of ideal fluids. Vorticity kinematics. Potential planar flows. Flow regimes and application to laminar and turbulent flows. Introduction to the boundary layer. Dimensional analysis and similarity. Numerical approach. Practical work: Nozzles, flow analysis by rheoelectric analogy, Poiseuille flows, verification of Bernoulli's principle, flow in a hydrodynamic tunnel, viscosity measurement, analysis of jets on plates and study of flow regimes.

020FOSMM1	Foundation Engineering	5 Cr.
------------------	-------------------------------	--------------

This course covers the following: Geotechnical properties of soils. Geotechnical investigation. Bearing capacity and settlement of foundations. Shallow foundations. Raft foundations. Retaining walls. Sheet pile walls and slurry walls. Deep foundations. Foundations on difficult soils. Soil improvement.

020MESMM2	Soil and Rock Mechanics	8 Cr.
------------------	--------------------------------	--------------

This course covers the following: General principles. Properties and classification of soils. Clay minerals. Compaction and road geotechnics. Water in soil. Permeability, flow and effective stress. Consolidation and settlements. Consolidation speed. Mohr's circle and soil failure theories. Introduction to rock mechanical properties. Environmental geotechnics. Laboratory: sieve analysis, hydrometer analysis, Atterberg limits, shear test, Proctor compaction test, oedometer consolidation test.

020RDMMM2	Strength of Materials	7 Cr.
------------------	------------------------------	--------------

This course covers the following: Beam theory. Axial loads. Flexion. Torsion. Shear force. Calculation of the critical load of a structure: Euler and Dutheil theories. Energy theorems: Clapeyron, Maxwell-Betti reciprocity, virtual work, Castigliano, Menabrea. Method of three moments. Foci method. Section cut method. Elastic center method. Laboratory: compression testing of concrete cylinders using ultrasound, extensometers, and torsion



testing; tensile testing of steel bars.

020PLSMM1	Structures Plastic Behavior	4 Cr.
------------------	------------------------------------	--------------

This course equips students with the basic elements of plasticity, currently used in the new calculation codes in civil engineering. Topics covered include: General principles of plasticity calculations and plasticity criteria; plastic tension and compression; plane plastic bending and the concept of a plastic hinge; plastic resistance of sections in the presence of interaction between internal forces; calculation of the collapse load of statically indeterminate structures using the step-by-step method and the theorems of limit analysis.

020BARMM1	Dams	4 Cr.
------------------	-------------	--------------

This course covers the following: Characteristics of soils and slopes. Design of flexible dams. Creation of artificial reservoirs. Embankment dams and appurtenant structures. Hydraulic concrete structures. Diversion dams. Channel design.

020SM1MM1	Small Project I	5 Cr.
------------------	------------------------	--------------

This course involves a small project in one of the subjects offered during the semester.

020PLCMM1	Plates and Shells	4 Cr.
------------------	--------------------------	--------------

This course covers the following: General principles and description of thin-walled elements. Flexion of circular and rectangular plates. Simplified theory of shells of any shape. Shells of revolution. Variational formulation of plate and shell problems. Geometry of surfaces.

020CISMM1	Shear Strength and Slope Stability	4 Cr.
------------------	---	--------------

This course covers the following: Reminder of the theory of stress and failure criteria. Evaluation of shear strength. Shear strength of sandy soils. Shear resistance of clayey soils. Cyclic shear strength. Introduction to constitutive models. Calculation of slope stability. Remediation of instability issues.

020DYNMM1	Structural Dynamics and Earthquake Engineering	4 Cr.
------------------	---	--------------

This course equips students with the necessary elements to understand the dynamics of structures and size them to withstand earthquakes according to the PS92 regulation. Topics covered include: Earthquakes - Single Oscillator - Multiple Oscillator - Response of a structure to an earthquake - Calculation from an accelerogram - Calculation from a response spectrum - Regulatory aspects - Structural modeling - Seismic design - PS92 rules: design, calculation, and construction – Applications – Study of some structures according to PS92.

020STRMM2	Structures	8 Cr.
------------------	-------------------	--------------

This course covers the following: Study and use of influence lines and their application. Study of arches. Rotation method. Hardy Cross method. Computer calculation of structures. Beams on elastic support. Beams on elastic soil. Displacement method. Fully intrinsic equations. Solicitations. Deformations. Study of structural stability. Use of structural calculation software.

b- Semesters MR3 and MR4

020COMMM3	Behavior of Materials	3 Cr.
------------------	------------------------------	--------------

This course covers the following: Deformation and kinematics. Conservation laws. Virtual work. Constitutive equation. Thermo-mechanics.

020CSAMM3	Calculation of Anelastic Structures	4 Cr.
------------------	--	--------------

This course covers the following: Step-by-step method. Static theorem. Kinematic theorem. Regulatory aspects. Optimization.



020EC2MM3	Advanced Calculation of Concrete Structures	4 Cr.
------------------	--	--------------

This course covers the following: Optimization of reinforcement. Limited redistribution of moments (comparison of methods). Design of reinforced concrete structural systems and their members according to EC2. Advanced torsion calculation. Reinforcement design for seismic calculation (with comparison between different codes).

020DYSMM3	Soil Dynamics	4 Cr.
------------------	----------------------	--------------

This course covers the following: Introduction to seismic geotechnics. Characterization of seismic movements. Laboratory and field site methods. Cyclic behavior of granular and clay soils. Liquefaction. Dynamic response calculation.

020SISMM3	Engineering Seismology	3 Cr.
------------------	-------------------------------	--------------

This course covers the following: Seismic hazard. Seismic risk. Zoning.

020EC3MM3	Advanced Calculation of Steel Structures	3 Cr.
------------------	---	--------------

This course covers the following: Calculation principles for Eurocodes 3 and 4. Calculation of assemblies. Design of composite slabs. Design of composite columns.

020CFOMM3	Design and Reliability of Structures	3 Cr.
------------------	---	--------------

This course covers the following: Reliability theory. Structural performance. Potential design risks. Capacity factors. Evaluation of the different variables that affect the design.

020SROMM3	Advanced Statistics and Operational Research	3 Cr.
------------------	---	--------------

This course covers the following: Decision analysis. Simulations. Markov decision processes. Response surface methodology. Regression analysis. Stochastic processes.

020MMSMM3	Advanced Modeling of Materials and Structures	3 Cr.
------------------	--	--------------

This course covers the following: Advanced nonlinear structural calculation. GMNIA. MNA. LBA.

020MSMMM4	Research Internship and Thesis	30 Cr.
------------------	---------------------------------------	---------------

This course covers research techniques. It is the culmination of four months of research in a research center or laboratory.

