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 imparts a sound scientific training in the field of civil engineering. This training offers students the possibility to prepare a thesis in civil engineering.
The topics concern the civil engineering sector (analysis of structures, behavior of materials, reliability of constructions, geotechnics, geology, soil mechanics and soil dynamics, plates and shells, modeling and calculation by finite elements, Eurocodes, seismic and dynamic calculations, mechanics of structures, soil-structure interaction, etc.).
This Master program aims to graduate:

- Teachers and researchers.
- High-level specialists, essential in the various concerned administrations and design offices.
- Foreign researchers: due to the importance of the problems addressed, opening up to foreign students from the Mediterranean basin can bring about a synergy advantageous to better common use of resources.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

Students will develop a set of skills that prepares them to meet 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, familiarizing the students with 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 suggest appropriate geotechnical solutions. This includes the modeling of soil-structure interactions and geotechnical risk assessment.
- Use of nonlinear calculation software: effective use of advanced modeling and simulation software.
- Project management: management of resources and skills necessary to plan and execute a project.
- Communication techniques: writing of detailed engineering reports, presentation of results in a clear and concise manner, efficient teamwork.

ADMISSION REQUIREMENTS

Candidates are selected based on their application file.

- Admission to the first semester of the Master (M1) for candidates holding a Bachelor in Physics or an equivalent diploma.
- Admission is granted to the third semester of the Master (M3) for:
  - Civil engineering graduates
  - Holders of a Master or professional Master in physics
  - Third year civil engineering students at ESIB (fifth year of higher studies)
  - Holders of a recognized equivalent diploma.

Candidates are selected 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 (6 Cr.). Shear Strength and Geohazards (4 Cr.). Plates and Shells (4 Cr.). Plastic Behavior of Structures (2 Cr.). Structural Dynamics and Earthquake Engineering (4 Cr.). Reinforced Concrete (6 Cr.).

Multidisciplinary Project: Building Design, Foundations and Structures (6 Cr.). Strength of Materials (6 Cr.). Fluid Mechanics (6 Cr.). Soil and Rock Mechanics (6 Cr.). Structures (6 Cr.). Statistics (4 Cr.).

PROGRAM REQUIREMENTS

This Master consists of 120 credits, divided in 4 semesters (M1, M2, M3, and M4) of around 30 credits each. The preparation of the Master includes:

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

Required Courses (120 Cr.)
Fluid Mechanics (6 Cr.). Foundation Engineering (6 Cr.). Soil and Rock Mechanics (6 Cr.). Statistics (4 Cr.). Strength of Materials (6 Cr.). Plastic Behavior of Structures (2 Cr.). Multidisciplinary Project: Building Design, Foundations and Structures (6 Cr.). Reinforced Concrete (6 Cr.). Plates and Shells (4 Cr.). Shear Strength and Geohazards (4 Cr.). Structural Dynamics and Earthquake Engineering (4 Cr.). Structures (6 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
020PLSMM1	Plastic Behavior of Structures	2
020FOSMM1	Foundation Engineering	6
020MEFMM1	Fluid Mechanics	6
020MESMM1	Soil and Rock Mechanics	6
020RDMMM1	Strength of Materials	6
020STAMM1	Statistics	4
	Total	**30**

Semester 2

Code	Course Name	Credits
020BEAMM2	Reinforced Concrete	6
020DYSMM2	Structural Dynamics and Earthquake Engineering	4
020STRMM2	Structures	6
020RCGMM2	Shear Strength and Geohazards	4
020PLCMM2	Plates and Shells	4
020PBAMM2	Multidisciplinary Project: Building Design, Foundations and Structures	6
	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

020MEFMM1 Fluid Mechanics 6 Cr.

This course introduces students to the basic principles of fluid statics and dynamics. Topics covered include: Fluid statics – Continuity equation – Momentum equation – Energy equation – Differential formulation of the governing equations - Potential flow theory - Dimensional analysis and similitude – Viscous fluid flow – Introduction to turbulent flow.

020FOSMM1 Foundation Engineering 6 Cr.

This course introduces students to the calculation methods and rules of the art in the field of design and construction of foundations and retaining structures. Topics covered include: Identify the mechanical and hydraulic properties of soils. Understand the principles of geotechnical investigation as well as the main field tests. Dimension conventional superficial foundations. Understand the principles of active and passive pressures, and apply them to the calculation of retaining walls and different types of walls. Excavations and Groundwater Control. Deep Foundations. Design the piles. Geotechnical Design.

020MESMM1 Soil and Rock Mechanics 6 Cr.

This course covers the following: Generalities. 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.

020STAMM1 Statistics 4 Cr.

This course introduces students to basic statistics. Topics covered include: Central limit theorem - sampling distributions - qualities of the estimators - Estimation by confidence intervals - estimation by the maximum likelihood method - estimation by the moment's method - tests of parametric hypotheses - Linear regression

(simple and multiple) - tests of non-parametric hypotheses - bootstrap - introduction to Bayesian statistics - Monte Carlo method - Monte-Carlo methods by Markov chains (MCMC) - approximate Bayesian calculation (ABC).

020RDMMM1 Strength of Materials 6 Cr.

This course enables students to understand the behavioral laws of materials, calculate and analyze the characteristics of the cross sections, as well as distribute the internal forces and stresses in the different elements of 2D structures and the deformations of these elements. Topics covered: Theory of beams – Characteristics of the cross section - Center of Gravity - Moment of inertia – Normal effort - Bending - Torsion - Shear – Combined loadings - Calculation of the critical load of a structure: Theory of Euler - Energy theorems: Clapeyron, Maxwell-Betti, Bertrand de Fonviolant, virtual works, Castigliano, Menabrea - Force method - Three moments method.

020PLSMM1 Plastic Behavior of Structures 2 Cr.

This course equips students with the basic elements of plasticity, currently used in the new calculation codes in civil engineering. Topics covered include: Generalities on plasticity calculation and plasticity criteria, Plastic traction and compression, Plane plastic bending and notion of plastic hinge, Plastic resistance of sections in the presence of interaction between the internal forces - Calculation of the collapse load of statically indeterminate structures: Using the step-by-step method, Using the theorems of limit analysis.

020PBAMM2 Multidisciplinary Project: Building Design, Foundations and Structures 6 Cr.

This course covers the design of foundations and structural elements of reinforced concrete buildings. Topics covered include: Calculation of the foundations of a building - Calculation of the structure and dimensioning of the structural elements of a reinforced concrete building.

020PLCMM2 Plates and Shells 4 Cr.

This course covers the theoretical elements needed to pre-dimension and analyze structural elements such as slabs, walls, roofs, tanks and folded structures. Topics covered include: General introduction on plates and shells - Kirchhoff's theory of plates - Bending theory of rectangular plates - Bending theory of circular plates - Theory of shells - Membrane theory of shells of revolution - Bending theory of shells of revolution - Junction of shells of revolution.

020BEAMM2 Reinforced Concrete 6 Cr.

This course consists of dimensioning reinforced concrete structural elements according to BAEL and Eurocode 2. Topics covered include: Introduction - General - Basis of semi-probabilistic calculation - Evolution of calculation methods for reinforced concrete - Characteristics of materials - Durability and Coating - Adherence - Constructive provisions - Theory of cracking - Simple traction - Study of columns - Simple compression - Composite bending - Study of beams - Simple bending - Shear force - Study of beams - Torsion - Seismic arrangements - Practical work: Strength of concrete (Mechanical compression - Sclerometer – Pundit test) - Test Los Angeles - Determination of concrete - Cleanliness of sand.

020RCGMM2 Shear Strength and Geohazards 4 Cr.

This course includes the following objectives: Understand influencing factors and plan the measurement of soil shear strength under static and cyclic loading modes; Understand the basis of soil rheology; Introduce the notions of the effect of earthquakes on soils in terms of failure mode; Analyze landslide problems in terms of slope stability, excavations and embankments. Apply geotechnics to environmental problems; Identify the nature of contaminants in the soil with their biological, chemical and physical properties; Understand the modes of transport of contaminants in order to calculate their concentration in time and space; Develop treatment methods for soil decontamination; Design landfills.

020DYSMM2 Structural Dynamics and Earthquake Engineering 4 Cr.

This course equips students with the necessary elements to understand the dynamics of the 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 - Rules PS92: Design, calculation and construction - Applications - Study of some works according to PS92.

020STRMM2 Structures 6 Cr.

This course covers structural forms; influence lines; effects of temperature loads on structures, analysis of arches, trusses, continuous beams, 2D frames, grids and 3D frames. Topics covered include: Calculation of 2D structures (Rotation Method and Hardy-Cross Method) - Study of Arcs - Study of 3D structures - Method of displacements - Study of the stability of structures - Study of influence, use of lines of influence and applications - Beams on elastic supports - Beams on elastic soil - Study of the effect of temperature on structures – Software applications.

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 aspect. Optimization.

020EC2MM3 Advanced Calculation of Concrete Structures 4 Cr.

This course covers the following: Reinforcement optimization calculation. Limited redistribution of moments (comparison of methods). Design of reinforced concrete structural systems and their members according to EC2. Advanced torsion calculation. Reinforcement in 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 basis for Eurocodes 3 and 4. Calculation of assemblies. Mixed calculation of slabs. Mixed calculation of columns.

020CFOMM3 Design and Reliability of Structures 3 Cr.

This course covers the following: Reliability theory. Structural performance. Potential design risks. Capacity factor. 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 process. Response surface methodology. Regression analysis. Stochastic process.

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 constitutes an introduction to research techniques. It is the synthesis of four months of research in a research center or laboratory.