

MODULE HANDBOOK

Academic year 2026/2027

SEMESTER 2	
Track 1: Mechanics of Structures	
Advanced Structural Design	6 ECTS
Nonlinear Structural Analysis	6 ECTS
Structural Rehabilitation of Buildings and Bridges	6 ECTS
Computational Structural Analysis of Infrastructures	6 ECTS
(Infra)Structural Health Monitoring and Control	6 ECTS

Module #1	ADVANCED STRUCTURAL DESIGN		
Information	Credit points: 6 ECTS	Workload: 51 contact hours	Mode: Compulsory
Instructor(s)	A. Madeo		
Content	The course provides advanced methods for the analysis and design of reinforced concrete, timber, steel and composite structures. Topics include finite element modelling, linear and nonlinear analysis, structural safety under static and dynamic loads, reduced-order models and seismic retrofitting. Students develop a complete structural project using commercial software and current design codes.		
Examination	Final oral examination: presentation and critical discussion of the structural project developed during the course, followed by questions on course topics. The final grade is expressed out of 30 and also considers laboratory work.		
Requirement for examination	Fundamentals of Structural Mechanics and Construction Engineering. A course project must be prepared for presentation at the examination. No formal prerequisite examination.		
Learning outcomes	Specific skills: - Understand the behaviour of complex reinforced concrete, timber, steel and composite structures. - Apply advanced structural modelling and linear/nonlinear analysis methods. - Design structures according to current regulations and prepare the main project documents. Transversal skills: - Critically evaluate results from commercial structural analysis software. - Independently apply previously acquired knowledge to structural modelling, analysis and design.		

Module #2	NONLINEAR STRUCTURAL ANALYSIS		
Information	Credit points: 6 ECTS	Workload: 51 contact hours	Mode: Compulsory
Instructor(s)	G. Garcea		
Content	The course addresses geometric and material nonlinearities in structures and infrastructures. Topics include large-displacement elastic analysis, equilibrium stability and bifurcation, nonlinear truss, beam, and shell models, path-following and arc-length methods, elastoplastic constitutive laws, limit analysis and shakedown. Tutorials involve MATLAB finite element algorithms and ABAQUS models of full-scale structures.		
Examination	Oral examination lasting 30-60 minutes, including presentation and discussion of a final report and two or three questions on the programme. The oral test and report discussion contribute equally to the final grade, expressed out of 30.		
Requirement for examination	Good knowledge of methods and tools for analysis in Structural Engineering. Basic knowledge of any programming language: MatLab, Python. Submission of the final report is required before the oral examination. No formal prerequisite examination.		
Learning outcomes	Specific skills: - Recognise the limits of linear formulations and model geometric and material nonlinear behaviour. - Apply incremental solution algorithms and finite element methods to nonlinear analysis and design. - Evaluate simplified code-based checks and develop MATLAB prototype codes. Transversal skills: - Solve structural mechanics problems through algorithm development. - Work in small groups and clearly communicate assumptions, limitations and numerical results.		

Module #3	STRUCTURAL REHABILITATION OF BUILDINGS AND BRIDGES		
Information	Credit points: 6 ECTS	Workload: 51 contact hours	Mode: Compulsory
Instructor(s)	F. Bencardino (lectures); R. Chimento (tutorials)		
Content	The course examines existing steel, reinforced concrete and masonry buildings and bridges. Topics include structural typologies, historical investigation and surveys, material characterisation and in-situ testing, damage diagnosis, structural modelling and safety assessment under static and seismic actions. It covers local masonry mechanisms, bridge components and foundations, vulnerability assessment, and traditional and innovative strengthening and rehabilitation techniques. Small-group tutorials support a rehabilitation project.		
Examination	Individual oral examination, approximately 30 minutes, including presentation and discussion of the course project. Five questions cover the project (three) and other course topics (two). The final grade, out of 30, considers project quality and the oral examination; the pass mark is 18/30.		
Requirement for examination	Good knowledge of the topics covered in the Structural Mechanics and Structural Engineering courses. A course project must be prepared for presentation at the examination. No formal prerequisite examination.		
Learning outcomes	Specific skills: - Assess the reliability, safety and structural deficiencies of existing buildings and bridges. - Model reinforced concrete and masonry structures in seismic areas and evaluate material properties. - Design strengthening and seismic retrofitting interventions using traditional or innovative methods. - Assess intervention effects on strength, stiffness, ductility and overall behaviour. Transversal skills: - Solve engineering tasks independently and collaborate on group projects.		

Module #4	COMPUTATIONAL STRUCTURAL ANALYSIS OF INFRASTRUCTURES		
Information	Credit points: 6 ECTS	Workload: 51 contact hours	Mode: Compulsory
Instructor(s)	S. Lopez		
Content	The course introduces computational methods for structural mechanics, including energetic principles, functional analysis, weighted residual methods and conforming/nonconforming finite elements. Topics cover the solution of linear and nonlinear systems and path-following methods. Tutorials develop source codes and apply numerical algorithms to structural mechanics problems, including geometric and material nonlinearities.		
Examination	Combined written/oral examination lasting approximately 90 minutes, assessing theoretical knowledge and the development and testing of numerical models. The final grade is expressed out of 30.		
Requirement for examination	Concepts and methods of Calculus and Structural Mechanics. No formal prerequisite examination.		
Learning outcomes	Specific skills: - Solve structural mechanics problems using computational techniques. - Model linear and nonlinear behaviour with finite element methods. - Develop numerical algorithms and prototype codes in Maple and C++, and understand commercial software for complex structures. Transversal skills: - Solve solid and structural mechanics problems through algorithm development. - Collaborate in small groups, present results and critically assess structural calculations.		

Module #5	(INFRA)STRUCTURAL HEALTH MONITORING AND CONTROL		
Information	Credit points: 6 ECTS	Workload: 51 contact hours	Mode: Compulsory
Instructor(s)	G. Porco		
Content	The course covers experimental control of construction materials, non-destructive testing and diagnostic protocols for structural safety assessment. Topics include measurement uncertainty, instruments for forces, displacement, strain and travel time, laboratory tests, static and dynamic structural monitoring, and continuous or remote monitoring of buildings and bridges. Innovative methods include internal and external fibre-optic sensors and ambient-noise techniques for screening and maintenance.		
Examination	Oral examination lasting 20-40 minutes, covering in-situ material characterisation, static and dynamic structural controls, and innovative monitoring methods.		
Requirement for examination	Knowledge of civil engineering materials, reinforced concrete, masonry and steel structures, structural theory and engineering, material testing, and basic measurement and control methods. Ability to find scientific reference material independently. No formal prerequisite examination.		
Learning outcomes	Specific skills: - Use non-destructive testing to assess traditional and innovative construction materials. - Evaluate the condition of reinforced concrete, masonry and steel structures. - Select measurement and data-acquisition systems for static and dynamic monitoring. - Understand remote monitoring and fibre-optic sensor applications. Transversal skills: - Interpret material properties and structural behaviour, solve technical tasks independently and collaborate in groups.		