ANNEX 1.2

DIDACTIC COURSE REGULATIONS
MASTER'S DEGREE IN STRUCTURAL AND GEOTECHNICAL ENGINEERING
CLASS LM- 23

School: Polytechnic and Basic Sciences
Department: Structures for Engineering and Architecture
Regulations in force as from academic year 2024/2025

CURRICULUM

LEGEND
TYPE OF TRAINING ACTIVITY (TAF):
B = Characterising
C = Related or supplementary
D = Activity of choice
E = Final examination and language knwoledge
F = Further training activities

Course in English
Possibility for the student to opt for the route entirely in English

I YEAR

Name Teaching	SSD	Module	CFU	Hours	Type Activities *(lecture, workshop, etc.)*	Mode *(in presence, remote)*	TAF	Disciplinary scope	Mandatory / optional
Fondazioni - I semester	ICAR/07	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Static and seismic foundation design - II semester	ICAR/07	single		72		In presence			
Dinamica delle Costruzioni ed ingegneria Sismica - I semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil engineering	Mandatory (one of your choice)
Earthquake engineering and structural control - I semester	ICAR/09	single		72		In presence			
Course of your choice from **Table B**	various	single	9	72	Frontal lesson	In presence	C	Related or supplementary	Mandatory (one of your choice)
Teoria e Progetto delle costruzioni in c.a. - II semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Theory and design of reinforced concrete structures - II semester	ICAR/09	single		72		In presence			
Teoria e Progetto delle costruzioni in acciaio - II semester	ICAR/09	single		72		In presence			
Theory and design of steel constructions - II semester	ICAR/09	single		72		In presence			

Analisi limite delle Strutture - II Semester	ICAR/08	single	9	72	Lesson front	In presence	B	Civil Engineering	Mandatory (one of your choice)
Limit analysis of structures - I semester	ICAR/08	single		72		In presence			
Course of your choice from **Table** B	various	single	9	72	Frontal lesson	In presence	C	Related or supplementary	Mandatory (one of your choice)

II YEAR									
Name Teaching	**SSD**	**Module**	**CFU**	**Hours**	**Type Activities *(lecture, workshop, etc.)***	**Mode *(in presence, remote)***	**TAF**	**Disciplinary scope**	**Mandatory / optional**
Consolidamento delle strutture in c.a. - I semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Progetto e consolidamento di strtutture in murature - I semester	ICAR/09	single		72		In presence			
Strutture speciali e Progetto di strutture resistenti al fuoco - I semester	ICAR/09	single		72		In presence			
Teoria e Progetto di ponti - I semester	ICAR/09	single		72		In presence			
Opere di sostegno - I semester	ICAR/07	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Dinamica dei terreni e geotecnica sismica - I semester	ICAR/07	single		72		In presence			
Curricular activities of the student's choice from **Table A3**	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Curricular training activities chosen by the student from **Table B (see note §)**	ICAR/07 ICAR/08 ICAR/09	single	9	72	Frontal lesson	In presence	C	Related or supplementary	Mandatory (one of your choice)
Curricular activities of the student's own choice from **Table B (see notes § and +)**	various	single	9	72	Frontal lesson	In presence	D	Independent student choice activities	Mandatory (one of your choice)
Knowledge of the English language		single	1	--	--	--	F	Further training activities	Mandatory
Internship	various	single	8	200	internship	In presence	F	Further training activities	Mandatory
Thesis dissertation	--	--	12	--	--	--	E	Other Activities	Mandatory

(§) Teaching may possibly be brought forward with regard to the year.

(+) CFU may be spent in whole or in part on teaching or on internship activities coordinated with the final examination. It is in principle possible for the student to choose an examination other than from table B, provided that it is congruent with the training pathway of the STReGA degree course. Any such choice is subject to the approval of the educational coordination committee, whereas the choice from table B is automatically approved.

Course in English

YEAR I									
Title Course	**SSD**	**Module**	**ECTS**	**Hours**	**Type activities**	**Course modalities**	**TAF**	**Disciplinary Area**	**Mandatory / optional**
Additional training requirements, if necessary **(Table C)** - I semester	Several	See Table C	0/9/18	/	Frontal lesson	In presence	D	Independent student choice activities	Mandatory if necessary
Earthquake engineering and structural control - I semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory
Limit analysis of structures - I semester	ICAR/08	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory
Static and seismic foundation design - II semester	ICAR/07	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory
Theory and design of renforced concrete structures - II semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Assessment and retrofit of structures - I semester	ICAR/09	single		72		In presence			
Theory and design of steel constructions - II semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (one of your choice)
Advanced metallic structures - II semester	ICAR/09	single		72			B		
Advanced applied engineering mathematics - II semester	MAT/07	single	9	72	Frontal lesson	In presence	C	Related or supplementary	Optional

YEAR II*									
Title Course	**SSD**	**Module**	**ECTS**	**H**	**Type activities**	**Course modalities**	**TAF**	**Disciplinary Area**	**Mandatory / optional**
FEM in non-linear structural analysis - I semester	ICAR/08	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (two to four of your choice)
Mechanics of composite and advanced materials - I semester	ICAR/08	single	9	72	Frontal lesson	In presence	C	Related or supplementary	
Assessment and retrofit of structures - I semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	
Theory and design of bridges - I semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	
Structural reliability - I semester	ICAR/09	single	9	72	Frontal lesson	In presence	C	Related or supplementary	
Advanced metallic structures - II semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	Mandatory (two to three of your choice)
Advanced applied engineering mathematics - II semester	MAT/07	single	9	72	Frontal lesson	In presence	C	Related or supplementary	
Innovative building materials[(1)] - II semester	ICAR/09	single	9	72	Frontal lesson	In presence	B	Civil Engineering	
Geotechnical modelling[(1)] - II semester	ICAR/07	single	9	72	Frontal lesson	In presence	C	Related or supplementary	
Tunnels and underground structures[(1)] - II semester	ICAR/07	single	9	72	Frontal lesson	In presence	C	Related or supplementary	
Internship	--	--	9	225	internship	In presence	F	Further training activities	Mandatory
Thesis dissertation	--	--	12	--	--	--	E	Final examination	Mandatory

[(1)] Second-year - II semester subjects that can be brought forward to the first year, subject to verification of the Bachelor's degree course and individual study plan by the Study Plan Committee.

*During the second year it is mandatory to choose at least two courses TAF B and at least two courses TAF C according to the Degree Programme.

Table A1 - Geotechnical Engineering List

Teaching or training activity	CFU	SSD	TAF
I YEAR			
Stabilità dei pendii (LM Environmental and Land Engineering) (II semester)	9	ICAR/07	C
Geotecnica delle Infrastrutture (II semester)	9	ICAR/07	C
Consolidamento dei terreni e delle rocce (II semester)	9	ICAR/07	C
(°) *Static and seismic foundation design* (II semester)	9	ICAR/07	B
II YEAR			
Opere di sostegno (I semester)	9	ICAR/07	B
Dinamica dei terreni e geotecnica sismica (I semester) ((if not chosen (°))	9	ICAR/07	B
Indagine e monitoraggio geotecnico (II semester)	9	ICAR/07	C
Tunnels and underground structures (II semester)	9	ICAR/07	C
Geotechnical modelling (II semester)	9	ICAR/07	C

Table A2 - Construction Science List

Teaching or training activity	CFU	SSD	TAF
I YEAR			
Limit analysis of structures (I semester)	9	ICAR/08	B
Analisi strutturale con gli elementi finiti (II semester)	9	ICAR/08	C
Modellazione strutturale (II semester)	9	ICAR/08	C
II YEAR			
Analisi sperimentale dei materiali e diagnostica delle strutture (II semester)	9	ICAR/08	C
FEM in nonlinear structural analysis (I semester)	9	ICAR/08	B
Mechanics of composite and advanced materials (I semester)	9	ICAR/08	C

Table A3 – Structural Engineering List

Teaching or training activity	CFU	SSD	TAF
I YEAR			
Complementi di tecnica delle costruzioni [compulsory, if the same teaching or Construction Technology II, has not already been taken for the degree (I semester)]	9	ICAR/09	C
** Teoria e Progetto delle costruzioni in cemento armato (II semester)	9	ICAR/09	B
* ** Teoria e Progetto delle costruzioni in acciaio (II semester)	9	ICAR/09	B
*Theory and design of steel constructions (*if not chosen *) (II semester)	9	ICAR/09	B
Theory and design of reinforced concrete structures (if not chosen **) (II semester)	9	ICAR/09	B
II YEAR			
*** Consolidamento delle strutture in cemento armato (I semester)	9	ICAR/09	B
*** Progetto e consolidamento di strutture in muratura (I semester)	9	ICAR/09	B
Strutture speciali e Progetto di strutture resistenti al fuoco (I semester)	9	ICAR/09	B
**** Teoria e Progetto di ponti (I semester)	9	ICAR/09	B
Costruzioni in Legno (LM Construction Engineering) (I semester)	9	ICAR/09	C
Diagnosi e terapia dei dissesti strutturali (LM Construction Engineering) (I semester)	9	ICAR/09	C
Assessment and retrofit of structures (if not chosen ***) (I semester)	9	ICAR/09	B
Strutture Prefabbricate (II semester)	9	ICAR/09	C
Sistemi informative per le costruzioni (BIM) (II semester)	9	ICAR/09	C
Innovative building materials (II semester)	9	ICAR/09	B
Theory and design of bridges (if not chosen ****) (I semester)	9	ICAR/09	B
Advanced metallic structures (II semester)	9	ICAR/09	B
Structural reliability (I semester)	9	ICAR/09	C

Table B - Lectures in Tables A1, A2, A3 and further lectures recommended below (Related or Supplementary Subjects)

Teaching or training activity	CFU	SSD	TAF
# Modelli e metodi numerici per l'ingegneria (I semester)	9	MAT/07	C
*Advanced applied engineering mathematics (*if not chosen #) (II semester)	9	MAT/07	C
Geologia Applicata (if not already taken for degree) (II semester)	6	GEO/05	C
Rischi Geologici nella progettazione di opere di ingegneria civile (I semester)	9	GEO/05	C
Project Management per le opere civili (II semester)	9	ING-IND/35	C

Table C - Courses for additional training requirements (if necessary) for students enrolled on the English language course

Teaching or training activity	CFU	SSD	TAF
Continuum mechanics (I semester)	9	ICAR/08	D
Structural engineering (I semester)	9	ICAR/09	D
Fundamentals of structural and geotechnical engineering (I semester): - Module 1: Continuum mechanics - Module 2: Geotechnical engineering - Module 3: Structural engineering	9 Module 1: 3 Module 2: 3 Module 3: 3	 ICAR/08 ICAR/07 ICAR/09	D

Table of Lessons Activated in the STReGA CdLM for the 'Minor TT - Smart Infrastructure Developer' (Minor Table A: Transversal training activities in the technical-scientific area specifically developed for the Minor)

Teaching or training activity	CFU	SSD	TAF
Metodi Computazionali in dinamica Nonlineare – II Semester	9	ICAR/08	D
Valutazione e monitoraggio delle strutture - II Semester	9	ICAR/09	D

ANNEX 2.1

DEGREE PROGRAM DIDACTIC REGULATIONS

INGEGNERIA STRUTTURALE E GEOTECNICA
(STRUCTURAL AND GEOTECHNICAL ENGINEERING)

CLASS LM-23

School: Polytechnic and Basic Sciences

Department: Structures for Engineering and Architecture

Didactic Regulations in force since the academic year 2024-2025

Course: **Advanced Applied Engineering Mathematics**	**Teaching Language:** English	
SSD (Subject Areas): MAT/07		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Skills related to the study, from both a theoretical and applicative point of view, of Mathematical Physics, using both analytical and geometric techniques.		
Objectives: The aim of the course is to introduce the fundamental principles of mathematical modelling for formalizing and solving advanced engineering problems. The course will provide basic knowledge of computational methods (i.e. finite difference and finite element), for parabolic, hyperbolic and elliptic problems. The numerical discussion of each type of equation will be always preceded by the introduction/derivation of the models. Moreover, the role of initial and boundary conditions will be pointed out with reference to physical situations. The numerical investigation will concern the development of special applications on MATLAB platform.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: The exam is constituted by an oral test to verify student knowledge and the discussion of a project which can be developed in groups (2-4 people) and is related to the application of the studied methodologies to an engineering problem selected in agreement with the Instructor. The evaluation will be quantified as follows: 50% for the oral exam and 50% for the project quality and defence.		

Course: **Advanced Metallic Structures**	**Teaching Language:** English	
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I/II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Methods and tools for the design and analysis of steel and aluminium structures.		
Objectives: Understanding the theoretical basis for the design methods prescribed by the current structural design codes for steel and aluminium structures, also through developing practical examples of applications.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral discussion of the theoretical topics and applications developed during the course.		

Course: **Assessment and monitoring of structures**		**Teaching Language:** English
SSD (Subject Areas): ICAR/09		**CREDITS:**9
Course year: II	**Type of Educational Activity:** D (Activity of choice)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Issues of actions on buildings and the resulting behaviors as a function of types and morphologies, materials and technologies. Assessments of vulnerability, reliability, safety, and durability. Experimentation, testing, monitoring of constructions.		
Objectives: Provide basic knowledge of the main characteristics of different types of existing structures and infrastructures in order to identify the critical issues that affect the life cycle of structures, both as a result of degradation and as a result of operational and/or exceptional actions. Provide basic knowledge of the tools and techniques to be used both for monitoring during structures and infrastructures operation and for carrying out maintenance work on them.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral examination with discussion of design homework.		

Course: **Assessment and retrofit of structures**		**Teaching Language:** English
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course is focused on general principles and detailed procedures for the assessment and retrofit of existing reinforced concrete and masonry buildings, including cultural heritage structures, with emphasis on the seismic action. First, the typical features, deficiencies and critical aspects of the structural response of existing structures are analysed. Then, the knowledge gathering process regarding geometry, material properties and structural details of existing buildings is discussed. Linear and nonlinear methods of analysis for existing buildings under seismic action are presented, as well as fundamentals of linear and nonlinear structural modelling. Capacity models for structural elements under flexure, shear and axial load are presented, aimed at the assessment of strength and displacement capacity. The performance-based approach to seismic assessment is discussed, also illustrating the comparison between demand and capacity at different Limit States in a spectral framework. Finally, strategies and techniques for retrofitting existing buildings are discussed, with traditional or innovative materials and technologies, illustrating how to choose the more adequate strategy and the more efficient technique based on the outcomes of the safety check performed after the assessment phase. A project exercise is assigned to the students, regarding the assessment and retrofit of an existing building, including knowledge process, modelling, safety assessment before retrofit, design of retrofit, and safety assessment after retrofit.		
Objectives: The student should be able to define a test campaign aimed at achieving a certain knowledge level of an existing structure, to understand the nonlinear response of an existing building under seismic action at the element and at the structural level, with respect to different performance levels, to understand the basic concepts regarding deformation capacity and strength of a structural element, distinguishing the different failure modes, to perform nonlinear modelling and analysis of a structure and safety checks, and to design an adequate retrofit program selecting the most appropriate strategy and technique based on the outcome of the safety checks.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: The exam will consist of an oral discussion on the topics illustrated during theory and practice lectures, as well as on the discussion of the project exercise.		

Course: **BIM Information Systems for constructions**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: methods and tools for the structural design and for the construction and the management of civil structures.		
Objectives: The course will provide the basic elements of BIM (Building Information Modeling) methodologies for the information management in the design, construction, and maintenance processes of civil works. The course will enable students to acquire the main tools to manage and share information through the BIM approach and to design in an interoperable environment, in collaboration with the various professional figures and stakeholders involved in the processes. It will also provide the main tools to operate with the main software applications.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: oral examination and practical test		

Course: **Complementary topics in structural engineering**		**Teaching Language:** Italian
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The scientific-disciplinary contents consist of theories and techniques aimed at the design of new structures. They include the analysis of actions on buildings and of members behaviour as a function of structural types, of materials and technologies. Methods and tools for structural design and construction of structures are presented.		
Objectives: The course deals with the study of: the continuous beam and 2D frames; basic methodologies for the design of reinforced concrete, prestressed concrete, and steel structural elements; foundation structures and stairs.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral exam aimed at verifying the student's theoretical knowledge and practical skills; the design exercises assigned during the course will also be discussed.		

Course: **Computational methods in nonlinear dynamics**	**Teaching Language:** Italian
SSD (Subject Areas): Icar/08	**CREDITS:** 9
Course year: I/II	**Type of Educational Activity:** D (Activity of choice)
Teaching Methods: in person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course, after a general introduction to nonlinear dynamics, with a quick historical excursus, intends to place particular emphasis on the most widespread nonlinear phenomena in applications and on the related computational methods used for the study of their response and their stability. Specifically, discrete and continuous systems will be considered, introducing basic concepts such as phase space, phase trajectories and portraits, periodic, quasi-periodic and chaotic responses, attractors and basins of attraction, Poincarè sections, stability of solutions and bifurcations, sub- and super-harmonic resonances, highlighting a wide range of phenomena typically exhibited by nonlinear dynamical systems (think for example, the problems of flutter instability that, together with other nonlinear phenomena, were responsible for the structural collapse of the Tacoma Narrow Bridge or synchronization phenomena, such as the pedestrian-structure interaction capable of destabilizing the dynamics of the Millennium Bridge pedestrian bridge in London, before it was adequately equipped with viscous dampers, resonant mass inertia dampers etc.). Paradigmatic models such as Duffing and Van der Pol oscillators, Lorenz and Rössler systems, logistics application and Feigenbaum tree etc. will be illustrated. Hints will be provided to applications of more strictly engineering interest such as, for example, nonlinear energy sinks (NES), which represent an interesting improvement of linear tuned mass dampers, allowing on the one hand the use of smaller masses and on the other a simultaneous expansion of the range of suppressed frequencies, or as the structural isolation from vibrations induced by ground movements due to the phenomenon of localization. Subsequently, attention will be paid to the main computational methods used for the study of nonlinear systems and their stability. In particular, distinct groups of methods will be considered, such as weighted residue methods, finite difference methods, asymptotic methods and variational iteration-collocation methods, as well as the concept of nonlinear normal modes (NNM), a tool widely used to study the forced responses of nonlinear systems.	
Objectives: Introduce students to the topics of structural analysis and calculation in a nonlinear field.	
Propaedeuticities: none **Is a propaedeuticity for:** none	
Types of examinations and other tests: Oral exam	

Course: **Continuum Mechanics**	**Teaching Language:** English	
SSD (Subject Areas): ICAR/08		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** D (Activity of choice)	
Teaching Methods: in-person. Blended for foreign students.		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Continuum mechanics: deformation analysis, stress analysis, constitutive behaviour of three-dimensional homogeneous materials. Analysis of elastic structures: equilibrium and compatibility. Stress and strain field in beam models. Yielding criteria. Stability of equilibrium paths. Plasticity.		
Objectives: The course provides the basics about the mechanics of solids and structures. Understanding of the kinematics of a structural systems, its degrees of freedom, under- and over-determined behaviors. Computation of constraint reactions and internal forces (analytically and graphically) of structural systems. Computation of strain and stress in solids of arbitrary section and loads. Safety checks.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Written and oral exam.		

Course: **Design and retrofit of masonry structures**		**Teaching Language:** Italian
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Scientific-disciplinary contents consist of the theories and techniques used for both the structural design and construction of new buildings, and the verification and structural rehabilitation of existing ones. Scientific-disciplinary content includes: actions on buildings, including the effects of seismic action; the behaviour of structures as a function of their type, morphology, and materials; methods and tools for structural design; vulnerability and safety assessments; historical building surveys, safety checks, and structural intervention solutions applicable to historic buildings and monuments.		
Objectives: The course, through lectures and design exercises, aims to provide the general criteria and methods for the simulation of the structural behaviour of masonry buildings, which constitute a high fraction of the Italian and world building stock. The course deals with both the design of new buildings located in seismic areas and the structural assessment and retrofit of existing masonry buildings, using traditional or innovative materials/technologies.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral discussion of the theoretical topics and the design project developed during the course.		

Course: **Diagnosis and Repair of Structural Failures**		**Teaching Language:** English
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods:in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Actions on structures; structural behaviour under varying their type, geometry, materials, techniques, technologies, and interaction with soil and environment; vulnerability and safety assessment; experimental testing, proof checking and structural health monitoring; safety checks and structural retrofitting of historical constructions and monuments.		
Objectives: To provide criteria and methods for structural assessment through analysis of structural failures and their causes, with the aim of risk mitigation and forensic engineering. (ii) To deliver fundamentals of structural repair under different conditions (emergency or normal) through alternative techniques (classical or innovative; local or global).		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral test		

Course: **Earth retaining structures**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/07		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The analysis, design and construction of geotechnical works such as excavations and retaining structures.		
Objectives: provide the theoretical aspects related to earth pressure and the computational procedures for the design and verification of retaining walls, bulkheads and anchorages subjected mainly to static loads, reporting some mention of the dynamic effects on the same structures. Tensional and deformation states in the surroundings of excavations for the construction of underground works in urban environments (e.g., station shafts, underground parking lots etc.) are also examined, taking into account the effects of subsidence induced on the ground plane.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: oral test covering both theoretical topics and discussion of one or more of the exercises carried out as part of the course.		

Course: **Earthquake Engineering and Structural Control (EESC)**		**Teaching Language:** English
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in-person (face-to-face)		

Contents extracted from the SSD declaratory consistent with the training objectives of the course:

Dynamics of elastic SDOF systems: free vibrations, steady-state and generic forced vibrations, response spectrum representation of input action - Dynamics of elastic discrete MDOF systems: periods and vibration modes, modal analysis technique - Dynamics of continuum systems: one-dimensional shear and flexural beams, wave propagation in a three-dimensional body - Dynamic testing of structures: free and forced vibration tests - Inelastic dynamic response of structures: method of analysis, local and global ductility, energy balance

Causes of earthquakes - Intensity and magnitude - Measurement instrumentation: seismometer, strong-motion accelerometer - Seismic waves - Amplification characteristics of surface waves and site response

Behaviour of constructions materials under dynamic loading: concrete, steel, other materials - Dynamic analysis of building structures: torsional vibration of space structures, site response, soil-structure interaction

Earthquake resistant design: fundamental aseismic planning, static and dynamic analysis procedures, design earthquakes (response spectra and time histories)

Dynamic structural control: classification (passive, active, semi-active an hybrid control), energy dissipation devices (viscous, visco-elastic, hysteretic and friction dampers), isolation and filtering devices, tuned mass dampers and tuned liquid dampers, semi-active (oleodynamic, electrorheological and magnethoreological) and active devices, design of structural control systems.

Objectives:

Scope of the course is to provide the required background knowledge of structural dynamics and basic methodologies for the design of engineered structures in seismic zones, as well as to conceive structural control systems able to reduce vibrations induced by other sources (wind, human and ambient born, traffic, industrial machines, etc.).

Propaedeuticities: none

Is a propaedeuticity for: none

Types of examinations and other tests:

A written midterm exam is assigned in the second half of the course during class hours. The final exam is oral and requires the student to demonstrate knowledge of all the topics covered during the course as well as discussion of the assigned homework problems. A regular continuous attendance of the course certainly allows to more easily and profitably pass the final exam.

Course: **Experimental analysis of materials and diagnostics of structures**	**Teaching Language:** Italian
SSD (Subject Areas): ICAR/08	**CREDITS:** 9
Course year: I/II	**Type of Educational Activity:** C (Related or supplementary)
Teaching Methods: in person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: **Measurements and instrumentation** - Setup of experiments, calibration and sensitivity, acquisition of signals. Data analysis. Estimation of the uncertainty of the measurement. Instruments and methods for carrying out the tests: instruments for measuring displacements, forces, strains, temperatures, crack opening, slope, vibrations and stresses, forces generation. Laboratory instruments. Experimental mechanics methods of strain and stress state analysis, photoelasticity, digital image correlation, Moiré methods, interferometry, speckle methods, thermoelastic effect, electrical strain gauge and strain gauge with optical fibers. **Material Controls** - The mechanical properties of structural materials and their mechanical characterization. Experimental campaigns. Crisis mechanisms. Masonry: controls with NDT techniques (non-destructive), sonic investigation, investigation with flat jacks, endoscopic investigation. **Controls and experimentation on structures** - Measuring systems for the control of deformations and displacements. Manual and automatic acquisition of displacement fields. Load tests on structures. Outline of system dynamics, structural response. Monitoring techniques: continuous, with fiber optic techniques, dynamic. The problem of structural identification and inverse problem of mechanics: framing of the problem and methods of identification. Static tests, processing of results. **Structural diagnostics** - Importance and outlining of the problem, cracks and instability on existing structures: visual analysis, survey of cracking frameworks, interpretation of causes.	
Objectives: At the end of the course, students will have acquired the basic theoretical concepts of experimental analysis and diagnostics combined with practical experiences in order to apply the methods and tools of the discipline to experimental stress analysis, non-destructive testing and structural monitoring. All aspects that are very useful in their future work as engineers.	
Propaedeuticities: none **Is a propaedeuticity for:** none	
Types of examinations and other tests: Oral exam	

Course: **FEM in nonlinear structural analysis**		**Teaching Language:** English
SSD (Subject Areas): ICAR/08		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Acquiring the basic knowledge and the methodological approaches typical of Computational Mechanics and Dynamics required to perform nonlinear time history analyses of structures by means of frontal lectures, numerical exercises and MATLAB programming.		
Objectives: Aim of the course is to illustrate the theoretical aspects and the numerical techniques underlying the analysis, in the static and dynamic case, of structures exhibiting geometrical and mechanical nonlinearities. Particular attention is given to the phenomenological modeling of complex hysteresis phenomena typical of mechanical systems, devices and materials.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral exam		

Course: **Finite element method in structural analysis**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR / 08		**CREDITS:** 9
Course year: I/II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Boundary value problems: Strong form of 1D elastic continua. The finite difference method. Variational form of 1D elasticity problems. The Rayleigh-Ritz-Galerkin Method. The finite element method for 1D problems: Shape functions. Stiffness matrix. Solution of structural equations. Finite elements of higher degree: shape functions. Plane stress and strain problems: Strong form for 2D continua. Shape functions. Stiffness matrix and nodal force vector. Triangular elements: Turner triangular element. Quadratic triangular elements. Quadrilateral elements: Bilinear quadrilateral element. Shear locking. Quadratic quadrilateral elements. Fundamentals of 3D problems. Truss structures: Total potential energy. Truss element. Finite Element Analysis of truss structures. Framed structures: Extension of the Euler-Bernoulli beam model to 3D structures. Strong form as a stationary point of the total potential energy. Weak form. Shape functions. Interpolation of nodal displacements. Basic concepts for the formulation of a beam element. The beam element in its local reference. Local to global reference transformations. Equilibrium of framed structures. Extension of basic beam element. Internal releases. Change of reference and kinematic conditions on degrees of freedom. Linear static analysis of frames. Dynamic analysis of frames: Mass matrix of beams and nodes. Dynamic equilibrium equations. Dynamic analysis methods.		
Objectives: The course aims to provide aspiring engineers with the methodological foundations and operational tools for the analysis of structures and elastic continua by the Finite Element Method. Acquiring the basic knowledge and the methodological approaches typical of Computational Mechanics with particular reference to the Finite Element Method by means of frontal lectures, numerical exercises and programming in MATLAB.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: During the course written homeworks regarding modelling exercises are assigned. The oral exam include the discussion of assigned homeworks and theoretical aspects presented in the course.		

Course: **Foundations**	**Teaching Language:** Italian	
SSD: ICAR/07		**Credits:** 9
Course year: I	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course aims to provide the principles, theories and analytical, computational and experimental methodologies for the physical-mechanical modelling of shallow and deep foundations and of soils and rocks interacting with them in the static and dynamic field. Foundations analysis, design and construction issues are contents of the course.		
Objectives: The course aims to provide the knowledge needed for foundations design, monitoring and recovery. Foundations interact with superstructures and soils and a correct design cannot neglect such interactions. To achieve the described objectives the course deal with the study of theories with the analysis of the respective fields of application, the description of the most widespread and efficient calculation procedures and the precise definition of calculation methods to meet the requirements dictated by the regulations in the field of new foundations design or reuse of existing foundations.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Combination of written and oral exam		

Course: **Fundamentals of structural and geotechnicalengineering** Module 1: Continuum mechanics Module 2: Geotechnical engineering Module 3: Structural engineering	**Teaching Language:** English
SSD (Subject Areas): Module 1: ICAR/08 Module 2: ICAR/07 Module 3: ICAR/09	**CREDITS:** 9 CFU Module 1: 3 CFU Module 2: 3 CFU Module 3: 3 CFU
Course year: I	**Type of Educational Activity:** C (Related or supplementary)
Teaching Methods: in-person	

Contents extracted from the SSD declaratory consistent with the training objectives of the course:

Module 1: The first module of the course is an introduction to the foundations of continuum mechanics. Kinematics of deformation. Linearization. The concept of stress. Constitutive equations. Yield Criteria. Elastic response. Work and energy. Theorem of virtual work. Simple problems in linear elasticity. The stress status in a 3D beam subject to axial force, bending moment, shear and torque.

Module 2: The second module of the course will consist of an overview of basic concepts and experimental tools needed to characterize and model the physical-mechanical soils properties for the analysis of their behaviour under working and limit design conditions.

Module 3: The third module of the course deals with general criteria and applicative techniques aimed at design, safety checks and construction aspects of reinforced concrete structural members and steel members. The Module includes: general concepts of structural safety and design of structures; mechanical behaviour and constitutive laws of structural materials, such as concrete and steel; design and safety checks of reinforced concrete structural members and steel members according to the semi-probabilistic limit states method (ultimate and serviceability limit states) and the most advanced international building codes as well as Eurocodes.

Objectives:

Module 1: The module is aimed at understanding of the principles and methods for the analysis of strength and behaviour of solids and structures. Awareness of the foundations and critical usage of the main models in the analysisof solids and structures.

Module 2: The module is aimed at introducing the students to the knowledge of soil mechanics and geotechnical modelling with special emphasis on their applications to the design of civil engineering structures. The students will be trained to derive soil properties to be used in the above applications from experimental laboratory tests and site investigations.

Module 3: The module provides the basic knowledge and methodologies for the calculation and safety check of reinforced concrete structural members and steel members within the semi-probabilistic limit states method, as well as the general criteria for the design of simple structures. During the course, reference is made to the principles inspiring the most advanced international building codes, as well Structural Eurocodes, and to the construction aspects and techniques.

Propaedeuticities: none
Is a propaedeuticity for: none

Types of examinations and other tests:

Module 1: During the module, practical written homework and simple numerical applications will be assigned regarding the topics covered in the class (continuum mechanics and beam analysis). The final exam will be oral and include the discussion of the assigned homework and numerical applications.

Module 2: During the module, practical written homework and simple numerical applications will be assigned regarding the topics covered in the class (soil mechanics and geotechnical modelling). The final assessment test will be oral, consisting of a questions and answers session on the topics of the course and of the classwork and include the discussion of the assigned homework and design applications.

Module 3: During the course, practical written homework and simple design applications will be assigned regarding the topics covered in the class (design of reinforced concrete members, design of steel members). The final exam will be oral and include the discussion of the assigned homework and design applications.

Course: **Geological risks in the project of civil engineering works**		**Teaching Language:** Italian
SSD (Subject Areas): GEO/05		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Basics of basic geology · Internal Constitution of the Earth; plate tectonics; volcanism; earthquakes. · Tectonics, and main geomorphological processes. · The main outcropping rocks (igneous, sedimentary and metamorphic). · The main geological domains of the centralsouthern Apennines: risks and resources. Notes on the main natural risks · The volcanic risk and the seismic risk · The risk of landslides; classification of landslides: study methods, interventions and monitoring. · Rapid debris-mud flows. · Slow-moving landslides. · Rock landslides. · Torrential alluvial phenomena. · Liquefaction and sudden sinking phenomena (sinkhole). · The hydrogeological risk and the PAI of the Basin Authorities. The analysis of photo interpretation in the design of engineering works - Drafting of basic maps through drone and laser scanner flights; orthophotomaps - Photo interpretation, stereoscopy, recognition of lithotypes, landslides and other morphologies and geological structures. - Exercises on both zenith and frontal stereoscopic pairs for the study of landslides. Areas affected by mud and debris flows - Photointerpretation; slope geomorphology; thickness of the pyroclastic cover; slopes. - Susceptibility to landslides and calculation of the run-out of landslides; estimate of the magnitude of landslides. - Notes on design choices for risk mitigation, interventions and monitoring plan. Areas affected by rock landslides - Photo interpretation of frontal stereoscopic pairs; geology and geomorphology of the wall. - Geological and structural layout of the wall; geomechanical laying and classification of the rock mass. - Susceptibility to collapse; breaking mechanisms and design block estimation. - Notes on the possible intervention planning choices and monitoring plan. Areas affected by slow-moving landslides. - Photointerpretation; geomorphological evolution of landslide slopes. - Anomalies of the hydrographic network and definition of the landslide body in plan. - Investigation plan to evaluate the depth of the sliding surface. - Design choices of interventions for risk mitigation; monitoring plan. Areas affected by hyperconcentrated flows of alluvial fans. - Photointerpretation; geomorphology and characteristics of the catchment area. - Geomorphology of the conoid apparatus; active and fossil conoids; conoids interlocked and superimposed. - Interactions of hyperconcentrated flows with the urbanized. - Definition of the survey campaign for the study of alluvial fans. - indications on the possible design choices of interventions and monitoring plan. The phenomena of liquefaction and sudden sinking (sinkhole) - Liquefaction phenomena and geological characteristics of the sites. - Natural sinkholes and karst areas. - Mining, underground cavities and anthropogenic sinkholes. - Interactions between sinkholes and engineering works. - Investigation plan for the recognition of underground cavities. - Notes on possible interventions and monitoring plan. Execution of detailed technical geological sections and application problems for the design of: Roads; railways; aqueducts; galleries; dams. Educational field-trip - Geostructural analysis of rocky ridges in landslide, geomechanical layings and classification of masses Guided tour of landslide areas and active alluvial fans and related risk mitigation interventions		

Objectives:
The course aims to provide the different study methodologies for the mitigation of "geological risk" in the design of civil engineering works. The gelogical-application problems associated with the stability of the slopes affected by both "fast" and slow moving landslides and areas susceptible to liquefaction or sudden sinking ("sinkhole") are dealt with. For the flood hazard, the study of torrential phenomena that feed active alluvial fans is undertaken. Students, also through photointerpretation analyses and on-site inspections, will have the opportunity to practice in the search for possible solutions for the mitigation of geological risk to be taken into account in the design of roads, railways, tunnels and dams.

Propaedeuticities: none
Is a propaedeuticity for: none

Types of examinations and other tests:
Written and oral

Course: **Geotechnical Infrastructures**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/07		**CREDITS:** 9
Course year: I / II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Slope stability, earth embankments, retaining structures.		
Objectives:		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: oral exam		

Course: **Geotechnical investigation and monitoring**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/07		**CREDITS:**9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: To furnish principles, theories and methodologies and procedures for the geotechnical characterization of the territory.		
Objectives: The course aims to give the student with knowledge on the tools, techniques, methods and criteria of soil investigations, as well as the procedures for interpreting the results, aimed at defining the "Geotechnical Soil Model" which is the basis of the design of a geotechnical work. Also illustrate the survey techniques of traditional and advanced instrumentation (SAR) used in the monitoring of geotechnical engineering works in relation to slope stability, foundations and retaining structures works. Through the development of a project related to a real case entrusted to groups of students, students will have the opportunity to apply the knowledge acquired in analogy to what is commonly done in the professional field.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral exam		

Course: **Geotechnical Modelling**	**Teaching Language:** English	
SSD (Subject Areas): ICAR/07		**CREDITS:** 9
Course year: I / II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: computational methodologies for the physical-mechanical modelling of soils and rocks and for the evaluation of their behaviour in the static field; the analysis and design of geotechnical structures such as foundations, underground constructions, excavations and retaining structures, embankments, and earth-constructions.		
Objectives: to provide students with theoretical and practical knowledge necessary for implementing numerical models for resolution of Geotechnical Engineering application problems. The course will deepen treatment of field equations for porous media and introduce constitutive relations used in geotechnical applications in a systematic way. The application of the finite element method to a series of Geotechnical Engineering problems is aimed at using the theoretical concepts acquired during the course.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: oral examination with discussion of a year's project		

Course: **Innovative Building Materials**	**Teaching Language:** English	
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The contents arise with the theory and technology for the structural analysis and retrofit of existing structures.		
Objectives: The course provides a basic knowledge on the use of innovative materials for the construction of new structural elements or for the retrofit of existing ones. The course addresses the criteria for the selection of the most suitable material for interventions and explains how to design, apply and check the strengthening solution for different structural typologies (RC and masonry constructions).		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral test and discussion of design projects assigned during the course.		

Course: **Limit analysis of structures (Analisi limite delle strutture)**		**Teaching Language:** Italian or english
SSD (Subject Areas): ICAR/08		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course provides an introduction to the evaluation of the collapse load of ductile structures under small displacements and to the evaluation of the collapse load on account of the loss of shape for non-linear structures. In particular, the following topics are covered: inelastic behavior of materials; laws of plastic flow; fundamental theorems of plasticity and of the limit analysis of structures; Eulerian instability; critical load and post-critical behavior; collapse due to loss of shape; instability in the inelastic field.		
Objectives: Knowledge of the general principles and methods for evaluating the load-bearing capacity of structures in elastoplastic and non-linear regimes.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Intermediate evaluation tests / written test. Oral interview.		

Course: **Mechanics of composite and advanced materials**		**Teaching Language:** English
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Thermo-mechanics of materials: anisotropy, elastic and plastic deformation, Deformation Theory and Stress Theory in Continuum Mechanics. Viscoelastic Constitutive Laws. Theory of Homogenization: concepts and definitions, analytical and numerical homogenization and localization techniques, derivation of overall properties and failure mechanisms in composites. Numerical Modeling – Introducion to FE Method. Design and FEM modeling of composite structures.		
Objectives: The course "Mechanics of Composite and Advanced Materials" aims to provide students with theoretical models, computational methods and numerical procedures for the study, the analysis and the design of structural systems made of composite and innovative materials, allowing the possibility of predicting the behavior of new composites and, eventually, to tailor and design new materials, considering also their nonlinear behavior. Theoretical lessons are interspersed with exercises and numerical applications.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: The oral exam consists in discussing topics covered in the course showing the ability to be able to fully use the theoretical and applicative tools that were provided during the course and to be able to discuss the possible applications of innovative materials in various structural engineering problems. The final grade will be determined on the basis of the outcome of the oral exam. Particular importance will have the ability of the student in discussing about the possible use of composite and advanced materials in engineering applications.		

Course: **Precast Structures**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Contents of the course concern theories and technics regarding both the structural conception, the dimensioning of new constructions and the verification and the structural rehabilitation of existing ones. So, they include the topic of the actions on constructions and the following behaviour depending on typologies and morphologies, materials and technologies, interaction with soil and environment; evaluation on vulnerability, reliability, comfort, safety and durability; methods and means for structural design and realization of structures.		
Objectives: Course intends to provide students with specialist knowledge concerning the design and analysis of RC precast structures, considering the specific peculiarities of the structural type. Furthermore, it intends to provide students with application details concerning the design and verification of RC pretensioned prestressed elements.		
Propaedeuticities: None. **Is a propaedeuticity for:** None.		
Types of examinations and other test: Oral examination		

Course: **Project Management for Civil Works**	**Teaching Language:** Italian	
SSD (Subject Areas): ING IND/35		**CREDITS:** 9
Course year: I / II	**Type of Educational Activity:** C (related o supplementary)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Contents extracted from the SSD declaration consistent with the educational objectives of the course: Introduction to Project Management.Il meaning of project according to the Project Management Institute (PMI). The life cycle of the project. Project Management processes according to PMI. The start of the project, the implementation of the project plan, the project charter. Project planning management: the project planning process: the definition of the project scope, the definition of the WBS (Work Breakdown Structure), the implementation of the WBS, the rules to be respected for the implementation of the WBS. The definition of organizational responsibilities in the implementation of the project: the Organization Breakdown Structure (OBS) and the Responsibility Assignment Matrix (RAM). The definition of tasks and the estimation of resources. Methods for estimating project resources: Bottom-up methods, Top-down methods, Estimation methods by analogy, Parametric estimation methods, Estimation methods based on expert opinion. Comparisons between the different methods and selection criteria. Project scheduling: the identification of the order of execution of the activities and precedence constraints, the construction of the project grid, the scheduling of the project through the Critical Path Method (CPM), the Gantt chart and its use in project planning. Peculiarities of the orders and of the planning and control cycle of orders in the field of Civil Works and Infrastructures The construction of the order estimate: the initial quotation estimate, the executive estimate, the updated estimate. The final balance of the costs of the order. Feed control. The Earned Value method and its applications. Variance analysis. The identification of corrective actions and the rescheduling of activities. The role of Project Management and the skills required to operate successfully in that role. The accredited international institutes for the certification of Project Manager skills, notes on the process related to the acquisition of the certification.		
Objectives: Develop the ability to plan and control, according to the dual temporal and economic dimensions, projects related to Civil Works and Infrastructures, through the appropriate and conscious use of Project Management techniques		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Discussion of a project developed within the course, relating to a specific type of project for which the student will have to develop and apply the planning and control methodologies illustrated during the course. Oral interview		

Insegnamento: **Retrofit of r.c. structures**		**Lingua di erogazione dell'Insegnamento:** Italiano
SSD: ICAR/09		**CFU:** 9
Anno di corso: II	**Tipologia di Attività Formativa:** B (Characterising)	
Modalità di svolgimento: In person		

Contenuti estratti dalla declaratoria del SSD coerenti con gli obiettivi formativi del corso:

Description of **knowledge process** of existing structures based on the current code provisions. Methods of investigation for determining material properties and structural detailing in existing structures. Analysis of the design methods based on previous code provisions and practice. Determination of structural detailing via simulated design. Fundamentals of performance-based approach for the **seismic assessment** of existing structures. Basic concepts regarding the response of elements/structures not designed according to modern seismic engineering.

Methods of linear and nonlinear, static and dynamic analysis for the seismic assessment of existing structures. Principles of spectral approach for the assessment of the seismic demand and capacity. Fundamentals of linear and nonlinear modelling aimed at the seismic assessment of existing structures. Capacity models for the assessment of ductile and brittle behaviour of existing members. Modelling and assessment of damage to nonstructural elements. Methods for the assessment of the seismic capacity and determination of safety level.

Retrofit strategies. Classification of interventions: local interventions, global interventions with partial upgrading, global intervention with full upgrading. Fundamentals and design approaches for retrofit strategies: (i) neutralization of brittle failures for the increase of strength and displacement capacity up to the first ductile failure; (ii) increase of displacement capacity only; (iii) reduction of displacement demand. Application of techniques based on the use of traditional or innovative materials and technologies. Project exercise regarding the retrofit of a reinforced concrete building including knowledge process, modelling, safety assessment before retrofit, design of retrofit, safety assessment after retrofit.

Obiettivi formativi:

The main objective of the course is showing the scientific, theoretic, and experimental sources of code prescriptions, in order to make students able to consciously and critically apply them. With special reference to the course syllabus, first, the knowledge of an existing structure process is analysed in terms of evolution of code provisions, consequent typical features and critical aspects of existing structures built in different ages, aims and methods for investigating geometry, materials and structural detailing of existing buildings.

Then, methods for seismic structural analysis are presented, including linear and nonlinear methods. This is aimed to make the students be able to perform nonlinear modelling, with a lumped plasticity approach, of a tridimensional reinforced concrete structure and to analyse it by adopting pushover analysis. Also, this is aimed to make the students able to consciously apply these analytical tools and correctly understand their results. Analyses' results in terms of demand must be compared with capacity limits. So, the course also focuses on capacity models for reinforced member elements under flexure and shear. This is done to make students able to perform the assessment of strength and displacement capacity of members, also considering the interaction between displacement demand and consequent damage with degrading capacity measures.

Finally, potential strategies and techniques for retrofitting existing reinforced concrete buildings are discussed. This will allow students learning how to choose the more adequate strategy and the more efficient technique based on the outcomes of the safety check performed after nonlinear analysis. This is also to highlight pros and cons of the strategies and techniques

proposed by literature and codes. To achieve all the above goals, theoretical lectures are associated with practical lectures in which the concepts at the basis of code provisions and code provisions themselves are practically applied and the outcome of this application is discussed and critically analysed.
Propedeuticità in ingresso: none **Propedeuticità in uscita:** none
Tipologia degli esami e delle altre prove di verifica del profitto: Oral exam

Course: **Slope stability**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/07		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: In-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course contents cover methods for slope stability analysis, including limit equilibrium methods, as well as the monitoring of landslide precursors. Additionally, it addresses technologies and design criteria for slope stabilization works.		
Objectives: The goal of this course is to provide theoretical and methodological knowledge for addressing slope stability issues in both soil and rock formations, particularly in settled areas where structures could be threatened by landslides and subsoil collapses. Additionally, the course aims to empower students to conceive solutions to improve slope safety suitable for each examined context and to design and verify them using methods of design practice, technological solutions, and current technical construction standards (NTC).		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Discussion of the design work carried out during the year and final oral exam.		

Course: **Soil and rock consolidation**		**Teaching Language:** Italian
SSD (Subject Areas): ICAR/07		**CREDITS:** 9
Course year: I / II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course covers theoretical and applied aspects concerning the analysis, design, construction and monitoring ofexcavations and underground works, the technologies and construction procedures for ground improvement, to stabilize slopes, structures, reclaimed land.		
Objectives: The course aims to give the student deep understanding of the most popular and most innovative technologies adopted for ground improvement. These technologies are nowadays becoming more and more popular, and in some cases more used than the traditional geotechnical ones. Therefore, it is of the utmost importance for the student to know these new ground improvement technologies, to understand the way they work, the soils or rocks for which they are best suited, and the applications for which they can be used. Through some exercises that simulate real case studies, the student will learn to design the ground improvement intervention considering also cost effectiveness for the most popular technologies.		
Propaedeuticities:none **Is a propaedeuticity for:** none		
Types of examinations and other tests: oral exam.		

Course: **Soil dynamics and earthquake geotechnical engineering**		**Teaching Language:** Italian
SSD (Subject Areas): ICAR/07		**CREDITS: 9**
Course year: II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course provides the basic elements for *'the analysis and the modelling of earthquake effects on soils and rocks, addressed to the prediction of the seismic response at both local and territorial scale, as well as to the assessment of site stability and of soil-structure interaction*[1]*'*		
Objectives: The course objective is to provide the concepts, the experimental and the analytical tools required for the analysis of the geotechnical problems relevant to the safety of the environment, the buildings and the infrastructures undergoing seismic actions. The course is specifically addressed to the engineering analysis of seismic ground motion and to the evaluation of its effects on the subsoil, with the aim of predicting the seismic site response, assessing the geotechnical stability and analysing soil-structure interaction in seismic conditions.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: The exam is an oral talk during which the exercises developed during the practice lessons will be discussed.		

[1] Translated after the recently updated declaratory of the SSD Geotechnical Engineering

Course: **Special structures and design of fire-resistant structures**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I/II	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: In-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: **Module 1 (Special structures)**: General information on steel-concrete composite structures. Composite slabs. Composite beams. Composite columns. Framed structures. Methods for structural analysis. Checks at the ultimate and serviceability limit states. Ductility and classification of sections. Plate theory. The static of pipes and cylindrical tanks. References to the membrane and flexure theory of shells and vaults. **Module 2 (Design of fire-resistant structures)**: General aspects about the safety check of structures in case of fire (prescriptive and performance based approaches). Thermo-mechanical properties of materials as a function of temperature. National and European regulatory framework. Definition of fire models. Thermo-mechanical analysis of structures subjected to fire, as normal and prestressed reinforced concrete, steel and steel-concrete composite members and structures. The students will design a steel-concrete composite structure in ordinary conditions and in case of fire.		
Objectives: Module 1 provides the general fundamentals for the calculation and design of specific structural types: steel and concrete composite structures; two-dimensional structures (e.g. plates); liquid containment structures and cylindrical tanks, with brief references to the vaults and shells. Module 2 provides the general design concepts and operational methods for the design and calculation of fire-resistant structures.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Oral exam and project discussion.		

Course: **Static and Seismic Foundation Design**		**Teaching Language:** English
SSD (Subject Areas): ICAR/07		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject content includes the analysis, the design and the construction techniques of shallow and deep foundations and the evaluation of their behaviour under static and seismic loadings.		
Objectives: A first part of the course aims at providing the necessary knowledge for the design, monitoring and the retrofitting of foundations in the static field. Foundations interact with structures in elevation and with the subsoil, and a correct design cannot be separated from the analysis of these interactions. The basis for achieving the described goal is the study of theories with the analysis of the respective fields of application, the description of the most common calculation procedures and the precise definition of calculation methods to meet the requirements specified by the codes of practice in the field of foundation design or the assessment of existing foundations. The second part of the course aims at providing the necessary knowledge for the analysis of the seismic geotechnical problems with reference to both shallow and deep foundations. In particular, for both shallow and deep foundations, the dynamic soil-foundation-structure interaction is analysed with methods with different degree of detail.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Combination of written and oral exam		

Course: **Structural dynamics and earthquake engineering**		**Teaching Language:** Italian
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: in person		

Contents extracted from the SSD declaratory consistent with the training objectives of the course:

Fundamentals of engineering seismology: origin of earthquakes, structure of the earth, volume and surface waves, recordings, magnitude, intensity measures of seismic shaking, source, propagation and site effects, attenuation laws, macroseismic intensity, magnitude scales.

Fundamentals of probability theory: random variables, subjective and frequentist interpretations of probability. Probabilistic calculation of seismic actions on structures: occurrence model of earthquakes at the source, Poisson process, estimate of the occurrence rate, hazard integral, process for the occurrence of intensity threshold exceeded at the site, distribution of magnitude and distance, distribution of the time of arrival, hazard curves, calculation of the hazard in the case of multiple sources, passage from rate curves to hazard curves, disaggregation, limit states and performance objectives, performance-return periods matrix, uniform risk in the performance-based approach.

Linear elastic single-degree-of-freedom systems: undamped free vibrations, damped free vibrations, logarithmic decrease of amplitude, forced vibrations with and without damping, resonance curve, dissipated energy, active and passive isolation of vibrations, elastic-linear single degree-of-freedom systems under harmonic forced vibration, elastic-linear single degree-of-freedom systems forced by a step function, response to the window function, impulse response, Duhamel integral, oscillations in the plastic range, the elastic-plastic oscillator; stiffness and strength degradation, dynamic equilibrium equations in the case of EPP systems; inclusion of ground acceleration in the equation of motion of a linear elastic single degree of freedom system; numerical integration algorithms: Wilson and Clough, Newmark.

Response spectra and design spectra: response spectra in terms of displacement, velocity and acceleration, pseudo-velocity and pseudo-acceleration spectra, spectral ordinates as measures of earthquake intensity, hazard in spectral acceleration, uniform hazard spectra and return period. Lumped-mass systems: matrix equation of motion, undamped system in free vibration, properties of the modes of vibration, Rayleigh ratio, equations of motion for systems with several masses with the deformability matrix, equations of motion in relative displacements, principal coordinates, proportional damping, non-proportional damping, elastic-linear lumped-mass systems masses acted-on by sinusoidal forces; dynamic loading due to support excitation, Holzer method, geometric non-linearity; static condensation of the stiffness matrix, principles of seismic isolation.

Seismic design principles: equal displacement rule; equal area rule; design spectra and linear static analysis, three-dimensional buildings, distribution of forces in static conditions (Engesser), centre of gravity of masses and elastic stiffness, extension of the equations of dynamic equilibrium to the case of three-dimensional structures, modal participation coefficients and effective masses.

Continuous systems: equation of motion and free vibration solution for the axially deformable beam and for the shear deformable beam, various cases of end constraint conditions, transverse oscillations of beam in bending, orthogonality of the eigenfunctions, vibration frequencies and eigenfunctions of the beams, modal analysis of continuous systems.
Objectives: Students are expected to develop an understanding of the fundamental issues related to structural earthquake engineering. The course aims to provide students with the knowledge and basic methodological tools necessary to analyse the dynamic behaviour of structures. These tools will allow students to understand the causal connections between the physical-mechanical phenomenon and the general criteria adopted for the seismic design of structures.
Propaedeutic courses: none **Is propaedeutic for:** none
Types of examinations and other tests: Midterm exam (optional), written and oral final exam.

Course: **Structural engineering**	**Teaching Language:** English	
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** D (Activity of chioce)	
Teaching Methods in person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Principles of structural safety and reliability behind modern design codes; partial safety factors for external actions and resistance in the structural Eurocodes. Serviceability and ultimate limit states. General properties of reinforced concrete and structural steel. Calculating support reactions, sectional forces and deflections for simple linear-elastic structural systems and frames under static loading; calculating normal and shear stresses according to beam theory. Reinforced concrete; materials and conceptual design. Design of reinforced concrete sections under normal forces: uniaxial and biaxial flexure, flexure under compressive or tensile axial force; design of reinforced concrete members against shear and torsion; fundamentals of reinforcement detailing and conceptual design: beams, slabs, columns and footings; calculation of deflections in cracked state and verification of serviceability limit states. Structural steel; Classification of cross sections; Resistance of cross-sections: tension, compression, bending moment, shear, torsion, combined actions; Buckling resistance of members: compression, bending, combined actions; Serviceability limit states for buildings. Connecting devices: bolted connections, welded connections; Structural joints; Composite floor slabs.		
Objectives: The scope of this course is to provide students with a solid background on the fundamentals of structural design (principles of structural design and reliability, calculation of sectional forces for typical frame structures, dimensioning of reinforced concrete and steel cross-sections and members, design and limit-state checks of simple structures). Theoretical lectures will be closely followed by sessions focused on practical applications of the material taught, which will be in the form of design examples.		
Propaedeutics: none **Is propaedeutic for:** none		
Types of examinations and other tests: Oral exam		

Course: **Structural Modelling**	**Teaching Language:** Italian	
SSD (Subject Areas): ICAR/08		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: In-person.		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Dissemination of innovative scientific tools to address problems related to assessment of mechanical behaviour, even in the presence of multiphysical couplings, and to design of buildings, organisms or structural elements of civil and industrial engineering, architecture and design, as well as all typical mechanical problems of bioengineering and other applied sciences. The covered topics concern statics, dynamics, equilibrium stability, fracture and fatigue mechanics and structural morphology.		
Objectives: The course aims at providing even complex knowledge and engineering methods with applications to structural computation.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: Written and oral test with project discussion.		

Course: **Structural reliability**		**Teaching Language:** English
SSD (Subject Areas): ICAR 09		**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: 1. Fundamentals of probability and statistics for structural engineering 2. Probabilistic and deterministic characterization of actions on structures 3. Methods of structural analysis to evaluate safety and reliability		
Objectives: Applications of probability and statistics for civil structures: characterization of natural actions (seismic, wind, floods, etc), modelling of uncertainty for structural materials, assumptions and methods of structural analyses for evaluating reliability. Knowledge of methods to evaluate the reliability of structural systems. Evaluation of risk of structures exposed to natural hazards (single and multiple hazards). Cost-benefit analysis for civil structures and infrastructure.		
Propaedeuticities: none **Is a propaedeuticity for:** none		
Types of examinations and other tests: The type of examinations and other tests is oral. Students are also requested to discuss a technical report based on assignment provided during the lectures.		

Course: **Theory and Design of Bridges**	**Teaching Language:** Italian or English
SSD (Subject Areas): ICAR/09	**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B (Characterising)
Teaching Methods: in-person	

Contents extracted from the SSD declaratory consistent with the training objectives of the course:

The aim of the course is to provide in-depth knowledge and advanced methodologies for bridge design and assessment. Bridge classification is illustrated, according to structural configuration of the superstructure and substructure and also construction method. Types of loads for design of bridge structures are classified. Girder type bridges are studied, considering decks with both prestressed reinforced concrete and composite steel-concrete girder cross-sections. The design theory of composite cross-sections and the role of construction stages on the performance of the bridge deck against SLS and ULS are explained. The role of the deck slab in the distribution of traffic loads, local effects induced by point loads and corresponding resisting mechanisms are introduced. The influence line theory, its application to road bridges and the role of transverse beams are taught. The fundamental principles of arch, curved girder, cable-stayed and suspension bridges are explained. Construction methods covered include conventional cast- in-place girder bridges, precast girder bridges, cantilever-constructed bridges and incrementally launched girder bridges. The role of bridges accessories, such as bearings, expansion joints and drainage details, is discussed. Structural dynamics of common bridge types are covered, along with a presentation of novel technologies for seismic protection, such as base isolation and energy dissipation devices. Fundamentals of bridge monitoring are explained including SHM, static and dynamic monitoring systems. Existing bridges are presented in terms of commonly encountered degradation phenomena, safety assessment procedures and available retrofit solutions.

Objectives:

The course provides the basic knowledge of bridge structural behaviour and modern construction methods and techniques. At the end of the course, students are expected to be able to successfully deal with the conceptual design phase of a bridge and to be able to process relevant information on the effects of external actions, in order to perform final design checks according to the semi-probabilistic limit states method. The aim of the course is to acquaint students with the basic methods and tools for design of new bridges and for assessment of existing ones. Homework assignments are expected to familiarize students with construction methods and techniques and modern international structural design codes.

Propaedeuticities: none

Is a propaedeuticity for: none

Types of examinations and other tests:

During the course, practical written homework and simple design applications will be assigned regarding the topics covered in the class. The final exam will be oral and will include the discussion of the assigned homework and design applications.

Course: **Theory and design of reinforced concrete structures**		**Teaching Language:** Italiian or English
SSD (Subject Areas): ICAR/09		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** B (Characterising)	
Teaching Methods: In-person		

Contents extracted from the SSD declaratory consistent with the training objectives of the course:

The course is focused on general principles and detailed procedures for the design of reinforced concrete (RC) buildings, with emphasis on seismic action. First, the methods of analysis for RC buildings under seismic action are illustrated, starting from the fundamentals of the dynamics of structures. Then, the nonlinear response of Single Degree Of Freedom systems is discussed, focusing on strength, stiffness and ductility concepts and introducing the behaviour factor approach. The conceptual design of RC buildings under seismic action is introduced, discussing the influence of aspects such as structural regularity. Then, Performance-Based Earthquake Engineering concepts are illustrated. Modern earthquake engineering principles, based on the capacity design approach, are introduced as well as seismic design rules. The hysteretic response of single structural members, such as beams, columns, and beam- column joints, is discussed, illustrating capacity models for strength and deformation capacity, and analyzing the influence of confinement on local ductility. Then, the detailed seismic design procedure is illustrated, from the application of capacity design concept to seismic detailing. During the course, reference is made to the principles inspiring the most advanced international building codes.

A project on the design of a RC frame building is assigned to the students and developed during the course.

Objectives:

This course strives to provide knowledge of the basic concepts regarding the fundamental principles of earthquake engineering and understanding of the modern approach to the seismic design of RC buildings. The students should be able to analyse simple moment-resisting frame RC structures, for design of new buildings, defining the actions and the structural model, applying a method of analysis, and carrying out safety checks at the Limit States of interest, complying with technical code provisions.

Propaedeuticities: none

Is a propaedeuticity for: none

Types of examinations and other tests:

The exam will consist of an oral test, focused on the theoretical discussion of the issues analysed during the course, including the discussion of the project.

Course: **Theory and design of steel constructions**	**Teaching Language:** Italian or English
SSD (Subject Areas): ICAR/09	**CREDITS:** 9
Course year: I / II	**Type of Educational Activity:** B (Characterising)
Teaching Methods: in-person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Conceptual design of steel structures and verification of resistance and stability	
Objectives: 1. To train the students about the theory and application of analysis and design of steel structures. 2. To train the students to design steel structures against gravity and seismic loadings. 3. To train the students to effectively use the standard formulas, tables, design aids, and computer software in the design and analysis of steel members.	
Propaedeuticities: none **Is a propaedeuticity for:** none	
Types of examinations and other tests: Oral test	

Course: **Timber constructions**	**Teaching Language:** Italian
SSD: ICAR/09	**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)
Teaching Methods: in person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Timber and timber based materials in constructions. Solid timber as structural material: physical and mechanical features. Solid structural timber grading according to strength and strength grades. Glulam and CL timber: the production process, mechanical properties and strength grades. Timber based products. Strength checks of cross sections. Buckling check of structural elements. Deformability checks. Structural elements of particular shapes. Composite beams and columns. Traditional carpentry joints and joints with cylindrical metal fasteners. Timber structural systems Seismic resistant structures. Ancient timber structures: structural safety evaluation and retrofitting interventions compatible with conservation requirements. National and European standards framework. Durability and protection issues. Behavior under fire. Design of an industrial building made of timber.	
Objectives: Provide deep knowledge about the physical and mechanical features of timber as structural material (both solid, glulam and CL timber), the structural systems and safety evaluation, for new and existing buildings, in the framework of European and national standards.	
Propaedeuticities: none **Is a propaedeuticity for:** none	
Types of examinations and other tests: Oral exam	

Course: **Tunnels and Underground Structures**	**Teaching Language:** English
SSD (Subject Areas): ICAR/07	**CREDITS:** 9
Course year: II	**Type of Educational Activity:** C (Related or supplementary)
Teaching Methods: in person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course covers theoretical and applied aspects concerning the analysis, design, construction and monitoring of excavations and underground works.	
Objectives: The course aims to provide the necessary knowledge for tunnel design. The following topics are presented and discussed: principles of tunnel design; ground investigations necessary for the definition of the geotechnical model; stability requirements of the excavation; stresses and deformations around a cavity in an elastic and elasto-plastic medium; calculation methods for the first-phase lining and the final lining; methods for the evaluation of the surface displacement field and the risk assessment procedures associated with excavation in urban area (effects on existing buildings and structures); seismic actions on tunnels; basic knowledge to set up a monitoring plan during the construction and operation phases of the work. Some simple calculations concerning the above topics are carried out in the exercises.	
Propaedeuticities: none **Is a propaedeuticity for:** none	
Types of examinations and other tests: Oral exam	