UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	CIVIL ENGINEERING
SUBJECT	DESIGN OF STRUCTURES IN SEISMIC AREA
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50353-Ingegneria civile
CODE	21872
SCIENTIFIC SECTOR(S)	ICAR/09
HEAD PROFESSOR(S)	COLAJANNI PIERO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	129
COURSE ACTIVITY (Hrs)	96
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**COLAJANNI PIERO** Monday 15:30 17:30 Edificio 8, Dipartimento di Ingegneria, Area Strutture, II piano Wednesday 15:30 17:30 Edificio 8, Dipartimento di Ingegneria, Area Strutture, II piano Thursday 10:30 12:30 Edificio 8, Dipartimento di Ingegneria, Area Strutture, II piano

DOCENTE: Prof. PIERO COLAJANNI

PREREQUISITES	Knowledge of: - structural analysis methods for elastic systems; -principles and methods of analysis and design of reinforced concrete structural elements; basic of structural dynamics and modal analysis
LEARNING OUTCOMES	KNOWLEDGE AND UNDERSTANDING The student will acquire the understanding on the behavior of structure loaded by seismic actions with special attention to reinforced concrete frames and masonry structure. The main topic covered by the course are seismic response analysis method, safety verification and design criteria, finalized to a discussion of the design rules and prescriptions of national and international design codes. APPLYING KNOWLEDGE AND UNDERSTANDING The students at the end of the course will be able to interpret the behavior of the structures in seismic zone, and to perform both the design of new structures and strengthening existing ones according the criteria and methods on which the recent international codes are based on. More emphasis will be devoted to reinforced concrete structures, while the main principles for masonry structures will be concerned. Moreover, the student will be guided in the path for understanding the role played by the dissipative capacity, and will learn the design technique based on the capacity design, from the basic principle through the detailing of structural elements and connections MAKING JUDGEMENTS The information gathered during the course will make the student able to detect the critical aspects of the seismic behavior of the structure, in order to recognize in each situation, the most suitable structural typology and design criteria for the design of new construction, or the most suitable strategy for strengthening of existing structures. COMMUNICATION The students will acquired the ability to communicate and debate issues concerning the dynamic and seismic behaviour of structures, with special emphasis on reinforced concrete frames structures, and will be able to discuss strategies and participate to problem solving in the ambit of professional studios and construction site.. Moreover, he/she will be able to describe and discuss ideas, vantage and disadvantages and offer different solutions to specialists, customer and official of public office for the evaluation of the design. LEARNING SKILLS The acquired concept and the design method will enable the student to deepen the topics discussed during the course, develop the learning skills necessary to continue his/her engineering studies with autonomy, and solve design problem for different structural typologies that are not concerned during the course
ASSESSMENT METHODS	Oral examination by discussion of a report developed during exercise course activity and individual study, containing the calculation report of a reinforced concrete spatial framed structure in a seismic area. The report contains the following sections: structural organization, load analysis and element sizing, evaluation of the effects of seismic action, structural analysis by equivalent static analysis and modal analysis with response spectrum; Executive design of one girder and one or more pillars, following the requirements of Italian and / or European codes for construction in seismic zone. The interview is aimed to assess the student's ability to process the acquired knowledge by using them to find solutions to the design problems that are being posed and to evaluate the quality of the founded solution. Knowledge of mechanical models, on which the techniques and the rules of analysis and project are based, will also be investigated. During the interview will be analyzed the student's ability to debate with a technically correct language on the content of the teaching. In particular, the student's ability to retrace the design pathway developed in the design report, applying design criteria, models and calculation rules, and evaluating the quality of the design solutions identified will be initially verified. Then we will investigate the ability to identify project criteria and apply models and calculation rules to other design problems analyzed during the course but not analyzed in the report. The evaluation is expressed in thirty with any ditinction, according to the following scheme: Excellent (30 - 30 and distinction) Excellent knowledge of subjects, excellent language skills, good analytical ability, the student is able to apply knowledge to solve project problems or verification of structures in the seismic area, including other than those contained in the report or developed in detail during classroom exercises. He knows the calculation models and regulatory requirements for their application. Very good (26-29) Good grasp of the topics. Sound language skills, , the student is able to apply knowledge to solve the proposed problems and is able to retrace the design process and the technical solutions identified during the design

	process. He knows the design criteria and calculation models on the basis of which he developed the design work. He knows the principles underlying the code prescriptions Good (24-25): Basic knowledge of the main topics, discrete language skills, with limited ability to apply knowledge to the problem solving. He knows the design criteria and calculation models on the basis of which he has developed the elaborate design, but in finding the right design solution he needs a guide. Satisfactory (21-23) He is not fully mastered in the main subjects of the teaching but possesses knowledge, satisfactory language property, poor ability to apply knowledge independently acquired. In the application of knowledge to problems similar to those contained in the design process, the solutions identified do not meet the requirements for effective operation, and regulatory requirements. Sufficient (18-20) Minimum basic knowledge of the main topics, teaching and technical language, very little ability to apply the acquired knowledge independently, and great difficulty in finding technically acceptable solutions even under the guidance of the examiner. Insufficient the student does not have an acceptable knowledge of the contents of the topics taught in teaching
EDUCATIONAL OBJECTIVES	The course aims at creating experts on the most updated criteria and methodologies for design and seismic vulnerability assessment of structures,with emphasis on the behavior of reinforced concrete frames and basic knowledge on the behavior of steel and masonry buildings. The course provide criteria, methodologies and technical expertise finalized to confer judgment ability in the development of design of new structures, starting to the choice of the most appropriate structural typology or the strengthening strategies for existing structures . All the activities are developed in framework of current structural performance based design codes regarding the construction materials, techniques and loads, with reference to serviceability and Ultimate limit states in order to ensure performance and safety levels
TEACHING METHODS	The course will be held in English language. Frontal lessons (28h) integrated by the projection of slides and films, numerical exercises (48h), and laboratory activities (20h) with the assistance of the teacher, also conducted through the use of spreadsheets, programming codes and calculation software, inherent verification and design problems of structural elements and the design of a reinforced concrete frame structure in a seismic area
SUGGESTED BIBLIOGRAPHY	Dispense del corso/ Course notes S.L. Kramer, Geotechnical Eartquake Engineering, Prentice Hall, isbn10:8131707180; ISBN13:978-8131707180 G.G. Penelis and G.G. Penelis, Concrete Buildings in Seismic Regions, CRC Press, Taylor & Francis Group, eBook ; ISBN9780429225345; DOI: https://doi.org/10.1201/b22364 Nuove Norme Tecniche per le Costruzioni - DM 14 gennaio 2008, pubblicato sulla Gazzetta Ufficiale n. 29 del 4 febbraio 2008 - Suppl. Ordinario n. 30 Circolare sulle "Nuove norme tecniche per le costruzioni" di cui al DM 14 gennaio 2008, pubblicato sulla Gazzetta Ufficiale n. 47 del 26 febbraio 2009 – Suppl. Ordinario n. 27. Eurocode 8 Design of structures for earthquake resistance Part 1: General rules, seismic actions and rules for buildings • Eurocode 8 Design of structures for earthquake resistance Part 3: Assessment and retrofitting of buildings Seismic Design of Reinforced Concrete Buildings by Jack Moehle, McGraw-Hill Education; 1 edition (October 28, 2014), ISBN-13: 978-0071839440

SYLLABUS

Hrs	Frontal teaching
4	Structural scheme of aseismic buildings; stiffness, strength and ductility; behavior of different structural typology; Principles and requirements of structure behavior in seismic zone. Limit states and design performance. Plan and height Irregular structures
3	Hints of structural dynamics, and seismology
4	The non linear behaviour of structures: monotonic and cyclic stress-strain and force-displacement laws, Moment-curvature law; plastic hinge, internal force redistribution, hints of limit and non linear analysis. The elastoplatic oscillator and non linear respone spectra of ducility demand and behaviour factor
4	From element ductility to structural ductility: the principles of pushover analysis; capacity design; pushover analysis for plane frames; hints of pushover analysis for spatial frames
8	Reinforced concrete structures: structural typologies and behavior factor; design criteria and rules; material constitutive laws and ductility; moment curvature relationship and curvature ductility of sections and displacement ductility of column; seismic shear walls: continuous model for frame wall dual systems and coupled shear walls; design and detailing of shear walls and coupling beams; code design rules; beam column joints

SYLLABUS

Hrs	Frontal teaching
3	Overview on the control systems of the seismic response of structures through base isolation and dissipation devices
2	Overview on the behaviour, verification and design rules for masonry structures subject to gravitational and seismic loads

Hrs	Practice
10	Analysis of framed structures by means of the displacement method; beam element bending and shear stiffness; Stiffness matrix of fixed nodes and movable nodes; Shear type frame. Translatant stiffness matrix, bending and shear distribution coefficients; Elastic systems connected in series and in parallel
10	The use of programming languages for the evaluation of the moment-curvature relationship of sections subjected to axial force and bending moment and the design of sections for given resistance and ductility
4	The non-linear static analysis of plane frames by means of a succession of linear analyses
12	Design and reinforcement detailing of reinforced concrete beams, columns, and beam-column joint according to the capacity design method
4	The use of FEM software for static and dynamic linear analysis of plane framed structures
8	Design of reinforced concrete shear walls

Hrs	Workshops
2	Evaluation of non linear displacement design spectra
4	Sizing of beam and column of reinforced concrete frames subjected to gravity and seismic loads
10	Software for static and dynamic linear analysis of spatial framed structures
4	Commercial Software for pushover analysis of plane frames