UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2017/2018
MASTER'S DEGREE (MSC)	BUILDING ENGINEERING
INTEGRATED COURSE	STRUCTURAL REHABILITATION OF BUILDINGS: ANALYSIS AND DESIGN - INTEGRATED COURSE
CODE	17093
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	ICAR/08, ICAR/09
HEAD PROFESSOR(S)	GIAMBANCO GIUSEPPE Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	MINAFO' GIOVANNI Professore Associato Univ. di PALERMO GIAMBANCO GIUSEPPE Professore Ordinario Univ. di PALERMO
CREDITS	12
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**GIAMBANCO GIUSEPPE** Monday 8:30 11:30 Laboratorio NDE - Edificio 8 Viale delle Scienze **MINAFO' GIOVANNI** Wednesday 09:30 11:30 Studio docente - Area Strutture Ed.8 o su Microsoft Teams (canale Didattica Telematica Prof. Minafo cod:122r83f)

DOCENTE: Prof. GIUSEPPE GIAMBANCO

PREREQUISITES	Mechanics of Solids; Beam theory; Strength criteria; Matrix and vectorial calculus; Stress and Strain state; Constitutive equations for ductile and brittle materials; Structural Analysis methods; Probabilistic safety approach; Ductility; Behaviour factor; Hierarchy of strength criteria.
LEARNING OUTCOMES	Knowledge and understanding: Knowledge of the design process which leads to the retrofit of existing buildings and to the possible structural modification for the change of use. General overview of the structural organism with the identification of the principal criticisms with the aim of assessing the seismic security. Applying knowledge and understanding: Identification of structural elements, physical-mechanical characterization and modeling technique for the structural response in presence of extern loads. Safety assessment and technical-economical study of different operative strategies. Making judgement: Evaluation of the needs of repair actions, the seismic vulnerability and choice of suitable strategies to mitigate the seismic risk. Communication: Capability to show to clients the actual condition of a buliding in terms of the damage state, safety to vertical and seismic loads, repair methods and the relative costs. Skills to discuss with the competence organism in the framework of structural retrofit of building. Lifelong learning skills: Capability to understand the design codes arising from Italian and foreign institutions. Possibility to learn new methods of structural analysis for static and dynamic, linear and nonlinear studies; new techniques for the reinforcement using traditional and modern materials.
ASSESSMENT METHODS	The exam consists of an oral exam with the support of a structural retrofit design project the students have to develop during the course. In addition to that, at the end of the first module, there is a written partial exam consisting in the resolution of a two-dimensional linear elastic frame structure using the finite element method. The in-itinere test does not contribute to the final mark. The oral examination requires the knowledge of the mechanical characterization of building materials; basic principles of the finite element method with the aim of modeling structures under static or dynamic conditions; techniques for the assessment of seismic vulnerability of existing structures; strengthening and seismic retrofitting techniques. The oral test shall be considered to have a positive result if the student satisfies at least two questions per topic for each module. The threshold of sufficiency will be achieved when the student has demonstrated an acceptable knowledge and understanding of theoretical and practical tools, adequate exposure skills and minimal ability to apply the acquired knowledge independently. The vote is expressed in thirtieths with possible praise, according to the scheme reported at the bottom of the degree program homepage, i.e. "Metodi di valutazione".
TEACHING METHODS	Frontal lessons, practice in classroom. Teaching and learning in classroom is supported by overhead slides (the pdf version of the slides is provided to all the students enrolled in the class on the teaching material section). Educational visits to the DICAM laboratory are planned.

MODULE
MODULE 2 - INTEGRATED COURSE ANALYSIS AND DESIGN OF STRUCTURAL BUILDING RECUPERATION

Prof. GIOVANNI MINAFO'

SUGGESTED BIBLIOGRAPHY

- S. Lombardo. Vulnerabilita' Sismica degli edifici esistenti in cemento armato. Dario Flaccovio Editore;
- G. Manfredi, A. Masi, R. Pinho, G. Verderame, M. Vona. Valutazione degli edifici esistenti in Cemento Armato, Collana di Manuali di Progettazione Antisismica, Vol. 5, IUSS Press;
- Dispense didattiche su argomenti ed esercizi svolti a lezione, fornite nel corso dello svolgimento dell'insegnamento.

AMBIT	50355-Edilizia e ambiente
INDIVIDUAL STUDY (Hrs)	98
COURSE ACTIVITY (Hrs)	52

EDUCATIONAL OBJECTIVES OF THE MODULE

Knowing in deep criteria and techniques for the assessment of existing reinforced concrete structures, with particular reference to seismic vulnerability, aiming to the definition of the retrofitting intervention. Learning methods and design rules of strenghtening and seismic retrofitting techniques for reinforced concrete structures by using traditional or innovative materials.

SYLLABUS

Hrs	Frontal teaching
4	Diagnostic and monitoring of reinforced concrete structures. Historic investigation. Geometric survey and crack patterns. Collapse of foundations. Damage due to earthquake.
3	Mechanical characterization of materials in existing RC buildings: concrete and steel. In-situ and in laboratory testing. Survey and monitoring of cracks. Measurement technology.
2	Knowledge levels and factors according to actual codes. Main features and structural deficiencies of existing buildings designed for gravity load. Simulated design for assessing structural details.
4	Capacity models for reinforced concrete members. Ductile and weak mechanisms. Moment-curvature relationship in existing RC sections. Definition of chord rotation in RC members and moment-rotation constitutive law for ductile mechanisms.
2	Capacity models for weak mechanisms. Shear capacity in RC members and in RC beam-to-column joints.
3	Structural analysis methods for the assessment of existing RC buildings. Applicability of linear analysis. Calculation of vulnerability index by linear analysis.
3	Effect of moment redistribution in non linear analysis and calculation of required rotational capacity; computational models for non linear analysis. Non linear static analysis for the assessment of existing RC buildings; Calculation of displacement demand and evaluation of vulnerability index.
3	Introduction to structural retrofitting. Traditional techniques for reinforcing existing RC members. Concrete and steel jacketing methods: confinement, and composite action for improving the axial and flexural capacity; improvement of shear strenght. Beton plaque method for retrofitting RC beams.
4	Introduction to the use of FRP composites for structural upgrading; CNR DT 200 guidelines about the use of FRP composites for the retrofitting applications; mechanical properties of FRP composites, preformed and wet lay-up systems; confinement of existing RC columns; debonding of composites, FRP-concrete bond behaviour and fracture energy; optimal anchorage lenght and flexural strenghtening of beams. Fundamentals about enhancement of shear capacity and strength of joints.

Hrs	Practice
4	Simulated design of a RC structure according to codes of the past.
4	Modal analysis of a RC structure by using a finite element code
4	calculation of the moment-rotation curve for a RC beam and for a RC column
6	Non linear static analysis by using a finite element code
6	Design of a retrofitting application in RC columns by steel jacketing and comparison with FRP wrapping method. Design of a FRP wet lay-up system for the flexural trenghtening of a RC slab.

MODULE
MODULE 1 - INTEGRATED COURSE ANALYSIS AND DESIGN OF STRUCTURAL BUILDING RECUPERATION

Prof. GIUSEPPE GIAMBANCO

SUGGESTED BIBLIOGRAPHY	
Dispense delle lezioni, J.K. Bathe, Finite Element Procedures, Prentice Hall, 1996.	
AMBIT	50355-Edilizia e ambiente
INDIVIDUAL STUDY (Hrs)	98
COURSE ACTIVITY (Hrs)	52
EDUCATIONAL OBJECTIVES OF THE MODULE	
Identification of the structural organism of building of the constitutive materials and their mechanical characterization through in situ and in vitro destructive and non destructive tests. Knowledge of basic concepts of computational mechanics and modeling of the structures in static and dynamic conditions by means of finite element method.	

SYLLABUS

Hrs	Frontal teaching
1	Introduction to retrofit of existing buildings
2	Geometric and material survey; historical and critical analysis of a building
1	Level of knowledge and confidence factors - Conventional strength evaluation
1	Non-destructive evaluation test
1	Structural modeling - Introduction to the finite element method
2	Principle of Virtual Work; Stationarity of potential energy
2	D'Alembert's Principle and Hamilton Principle
2	Shape functions; Numerical integration by means of Gauss quadrature
2	Isoparametric finite elements
4	Truss and beam finite elements
4	Plate-shell elements
4	Finite elements in dynamics; Modal decomposition
2	Introduction to elasto-plasticity

Hrs	Practice
4	Programming in MatLab environment - basic operations
4	Mechanical characterization of materials through destructive and non destructive tests
4	Beam finite element formulation in MatLab
4	Finite element solution of a 2D frame in static and dynamic
4	Shell-plate finite element formulation in MatLab
2	Introduction to the commercial FE softwares
2	Simulation of exercises (exam format)