UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
BACHELOR'S DEGREE (BSC)	MARINE TECHNOLOGIES ENGINEERING
SUBJECT	MECHANICAL DESIGN
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50302-Ingegneria meccanica
CODE	21651
SCIENTIFIC SECTOR(S)	ING-IND/14
HEAD PROFESSOR(S)	PITARRESI GIUSEPPE Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**PITARRESI GIUSEPPE** Tuesday 14:00 15:30 Ufficio del docente (stanza O119) ubicato Edificio 8 primo piano plesso dell'Ex Istituto di Costruzione di Macchine (in fondo al corridoio centrale). Thursday 14:00 15:30 Ufficio del docente (stanza O119) ubicato Edificio 8 primo piano plesso dell'Ex Istituto di Costruzione di Macchine (in fondo al corridoio centrale).

DOCENTE: Prof. GIUSEPPE PITARRESI

PREREQUISITES	Students should have the basic knowledge of physics of solid matter, Materials, Mechanics of Solids that is provided by the following courses: "Fisica 1", "Tecnologia dei materiali", "Disegno assistito da calcolatore", "Scienza delle Costruzioni".
LEARNING OUTCOMES	Knowledge of: Students attending the course will gain knowledge on: - How to set up and solve the elastic problem through the concepts of stress and strain and the relative governing equations; - Modelling the stiffness and strength behaviour of structural materials under static and dynamic conditions; - Basic knowledge on the experimental characterisation of the mechanical parameters used for design and validation of structures; - Employ the methodologies used to model the mechanics of Materials and Structures for the design and validation of specific components and structural cases. Comprehension of: Students attending the course will gain the ability to comprehend how the shape and type of material employed for a structural task will influence the ability of the structure to deform and resist the in-service loads that it is destined to experience. The students will gain a basic knowledge that will allow them to comprehend the most advanced design methodologies based on analytical, experimental and numerical approaches. Ability to: From the theoretical knowledge and comprehension of the design methodologies and through the lab and exercise activities, students will gain the ability to: - identify the most appropriate structural model and simplifications to validate or design a component; - be able to identify the most appropriate material and material mechanical model for a structural task; - have a basic knowledge of the material properties needed to model a structural case and how to determine them through standardized and experimental procedures. - implement analytical or numerical models to solve specific structural problems.
ASSESSMENT METHODS	Only one oral examination is required. A typical exam will last between 30 and 60 minutes and will be structured as follows: - two question on the first part of the course focusing on the Mechanics of Materials; - two question on the second part of the course focusing on the application to structural cases (e.g. joining techniques) and design of machine components; - one question on the exercises and practical experiences performed in the classroom. The student is advised to supplement his/her oral exposition with written analytical and graphical represention. The following aspects of the exam performance will be considered and marked: a) The level of details; b) The clearness of the answer and proper use of technical terminology; c) The effectiveness of using graphical and mathematical representations to derive knowledge and supplement the oral exposition; The above described four performance factors (a,b,c) will receive a separate mark that can be quantified as follows: Excellent (from 9 to 11 points): Very good knowledge of all topics and relative interactions (a), very good technical language skills (b), very good ability to derive analytically answers to problems (b,c), the student is able to apply the knowledge in an elegant and effective way to solve problems and answer questions (c) Good (8 points): Good knowledge of all topics (a), good technical language skills (b), good ability to apply the knowledge to derive answers to problems (b,c). Sufficient (from 5 to 7 points): has complete knowledge of topics but shows a limited ability to use such knowledge (a), comprehensible technical language skills (b), the student has a limited ability to describe and solve problems analytically, with only sufficient drawing skills (c). Not Sufficient (from 0 to 4 points):

	has a not-complete knowledge of topics and shows a lack of ability to use such knowledge (a), low technical language skills (b), the student has a lack of ability to describe and solve problems analytically without the help of the teacher (c). The final mark will result from adding the scores assigned to each performance factor: a,b,c. An example is as follows: a=10, b=7, c=5, 4will gain a final mark of 22. The maximum vote of 30&Lode is obtained when the total score is higher than 30.
EDUCATIONAL OBJECTIVES	The course provides knowledge on the principal modelling methodologies of the mechanical behaviour of structural materials, with a more focused aim to implement this knowledge for the design and validation of the structural performances of components and structures. The students will learn about the mechanical characterisation of materials with the aim to model their stiffness and strength behaviour. In particular, the student will be able to distinguish and classify materials according to their brittle or ductile behaviour, proposing and implementing the most appropriate methodologies and concepts for correct modelling of damage onset and failure conditions, both under static and dynamic forces.
TEACHING METHODS	The course comprises about 38 hours of lectures and 16 hours of laboratory activities where the theory will be implemented on some important structural engineering problems. Lectures will consist of oral presentations assisted by the contemporary use of multimedia power-point projection and checkboard. Lab activities will consist of practical aspects of measurement of mechanical properties and the structural design of specific components and structures. The use of multimedia will enhance the experience during practical activities (videos of lab experiences, virtual measurement instruments, introduction to Matlab for numerical impèlementation of design analyses).
SUGGESTED BIBLIOGRAPHY	- Dispenze e slides del docente; - Norman E. Dowling, Mechanical Behavior of Materials, Pearson. - Shigley - Progetto e costruzione di macchine 3/ed di: Richard G. Budynas e J.Keith Nisbett, McGraw-Hill; - A. De Paulis, P. Forte, F. Frendo, E. Manfredi, Costruzione di macchine, Pearson

SYLLABUS

Hrs	Frontal teaching
2	Course overview. Stiffness and Strength characterization of structural materials. Classification of structural materials and brittle and ductile behavior. Modelling of structural behaviour and design of machine components and structure.
3	Overview of Continuum Mechanics and Theory of Elasticity. Stress and Strain tensors. governing equations: equilibrium, compatibility, materials constitutive laws. Structural elastic behaviours: isotropic, anisotropic, orthotropic. Overview of the mechanics of composite materials.
3	Energy approach and theorems for structural mechanics. The concept of strain energy. The principle of virtual works applied to materials and structures. Clapeyron and Castigliano's theorems. Implementation of energy concepts in the experimental characterisation of mechanical properties.
2	Strength criteria for ductile material behavior.
1	Strength analysis with brittle materials.
2	Notches sensitivity and stress raisers.
2	A short overview of fracture mechanics. Fracture toughness in brittle materials and the Stress Intensity Factor approach.
12	High Cycle Fatigue. Low. Cycle Fatigue. Fatigue crack propagation and Paris law.
4	Shafts and axles. Design criteria under static and fatigue conditions.
7	Design of joints. Fasteners. Welded joints, Riveted Joints. Friction joints.

Hrs	Practice
3	Stress-strain distribution in bars.
3	Experimental evaluation of materials design parameters from tensile tests.
2	Experimental evaluation of materials design parameters from tensile tests.
3	Evaluation of the strain field by means of Strain Gauge rosettes and the Mohr's circle construction.
3	Design and validation of a power transmission shaft under fatigue loading.

Hrs	Workshops
2	Experimental characterisation of the stiffness and strength behaviour of structural materials. Universal Testing Machines.