UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	BIOMEDICAL ENGINEERING
SUBJECT	MECHANICS OF MATERIALS AND THEORY OF STRUCTURES
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50301-Ingegneria dei materiali
CODE	06313
SCIENTIFIC SECTOR(S)	ICAR/08
HEAD PROFESSOR(S)	BOLOGNA EMANUELA Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**BOLOGNA EMANUELA** Thursday 10:00 13:00 studio secondo piano area strutture

DOCENTE: Prof.ssa EMANUELA BOLOGNA

PREREQUISITES	Calculus, Physics I, Physics II, Linear Algebra
LEARNING OUTCOMES	Knowledge of Mechanics of Solids and Structures: The student at the end of the course will have knowledge of the problems concerning the mechanical behavior of elastic solids and their assembly to compose structure and he will be able to solve cases of engineering interest. Comprehension of Mechanics of Solids and Structures The student will be able to study the behavior of elastic solids, particularly of beam systems, subjected to external stress and to identify the most dangerous internal actions for the useful life of the structures studied Ability to make judgments: The student will be able to interpret the mechanical behavior of the structure studied under design loads and make predictions about its ability to withstand the loads. Ability to communicate: The student will acquire the ability to communicate and express issues concerning the object of the course. It will be 'able to sustain conversations regarding the structural aspect and the security of the cases considered. Ability to comprehend: The student will have 'learned the basic knowledge of solid mechanics and will be able to continue his engineering studies including the aspects related to structural problems in its preparation.
ASSESSMENT METHODS	Evaluation of Learning by means of three kind of tests: Written exam (45 % 3 hours) Multiple choice exam (5% 5 minutes) Oral exam (50% 15 minutes) The written test aims to confirm the abilities, capabilities and knowledges of structural mechanics topics of the course. The stimuli, well-defined, clear and with unique meaning allows to formulate an autonomous answer and to compare the results. The evaluation is in 30/30. The evaluation of the computational mechanics abilities is obtained by means of a specific colloquium about the numerical results provided by the student during the class for a prescribed computational biomechanics problem. The colloquium lasts for five minutes, The evaluation is in 30/30 Final grade is the weighted average of the three grades with weight, respectively, 0.45, 0.05, 0.50 Indicator - Knowledge and competence of contents Descriptor and score range: Excellent 30 Autonomous and effective 26-29 Acceptable 20-25 Fragmentary or partly superficial 12-19 Inadequate 0-11 Indicator - Applicative skill, precision, logical-thematic coherence Descriptor and score range: Excellent 30 Adequate 26-29 Acceptable also if partly driven 20-25 Limited 12-19 Inadequate 0-11 Indicator - Expression and terminology, reprocessing skills and multi-disciplinary connections Descriptor and score range: Excellent 30 Effective and well-structured 26-29 Generally satisfactory 20-25 Hesitant and rough 12-19 Inadequate 0-11
EDUCATIONAL OBJECTIVES	The course aims to provide the fundamentals of the mechanics of elastic continuum and the basic tools for the study of the static beam systems. The definitions of stress and strain in three-dimensional solids and the constitutive behavior of materials are defined. It is also addressed the study of the internal stresses in the articulated beam systems. It is introduced the study of the elastic problem of Saint-Venant under various load cases and studied articulated elastic beam systems using beam theory to predict their safety coefficients.
TEACHING METHODS	Lectures, Applications

SUGGESTED BIBLIOGRAPHY	M. Di Paola, A. Pirrotta: Dispense del corso; Ed. C.O.G.R.A.S. Polizzotto C.: Scienza delle Costruzioni; Ed. C.O.G.R.A.S. Viola E.: Scienza delle costruzioni Vol. I, III; Ed. Pitagora ISBN 978-8837106652, 978-8837103569 Gambarotta L., Nunziante A., Tralli A.; Scienza delle costruzioni, Ed. McGraw-Hill ISBN 8838666970 Falsone G., Meccanica delle Strutture, Ed. Aracne, ISBN 8854868590 Casini P., Vasta M., Scienza delle Costruzioni, Ed. Citta' Studi, ISBN 8825174276 Oomens C.; Brekelmans M.; Baijens F., Biomechanics:Concepts and Computation, Cambridge Texts in Biomedical Engineering, ISBN 9780521172967

SYLLABUS

Hrs	Frontal teaching
2	Mechanical properties of materials: Simple traction test, Young modulus, Poisson coeffcient, Simple torsion test, Transverse elasticity modulus.
5	Statics and kinematics of plane beams: Restraints, Kinematics of restrained structures, Statics of restrained structures, Well-restrained structures, Force balance equation, Internal actions for statically determined beams.
16	Stress and strain in 3d solids: Traction vector, Cauchy solids, Balance equations, Principal stresses, Mohr circles, Kiematics of strain, displacement gradient, Pure strain, Implicit kinematic conditions, Principal strain, Bulk strain
6	The elastic equilibrium problem: Stress-strain relations, The generalized Hooke relations, Internal stiffness matrix, Internal Compliance matrix, The elastic equilibrium problem, Navier equations, Beltrami equations, Non-linear elasticity, Free energy, Hyperelasticity, Material hereditariness
15	The Saint-Venant elastic solid, Solutions of the Beltrami equations, Prandlt formulation in torsion of simple connected cross-sections, Membrane analogy, Torsion in open and closed thin-walled cross sections, Jourawsy shear teory, Center of shear
5	Principle of virtual powers, Dual principle of virtual powers, Muller-Breslau approach to the solution of statically indeterminate structures, Betti Theorem, Maxwell theorem, Principle of the minimal potential energy, Principle of the minimal complementary potential energy.
4	Beams in flexure: Mass geometry, Static moments, Center of masses, Moment of inertia, Principal directions of inertia, Bernoulli-Euler beams, The Differential equation of the elastic beam.
2	The truss structures: Node balance equations, Methods of Solutions
2	Strength of materials: safety coefficients, Galileo criterion, De Saint-Venant criterion, Beltrami criterion, Huber-Mises-Henky criterion, Tresca criterion
1	Instability of elastic equilibrium, Euler critical load, Critical length, Slenderness factor

Hrs	Practice
6	Statics of beams and frames, graphical methods
12	Analysis of beams internal actions
6	Mass geometry
6	Stress analysis in De Saint-Venant elastic solid
3	Evaluation of displacements in elastic structures