UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2019/2020
BACHELOR'S DEGREE (BSC)	BIOMEDICAL ENGINEERING
SUBJECT	BIOMECHANICAL CONSTRUCTIONS
TYPE OF EDUCATIONAL ACTIVITY	D
AMBIT	10437-A scelta dello studente
CODE	18408
SCIENTIFIC SECTOR(S)	ING-IND/14
HEAD PROFESSOR(S)	ZUCCARELLO BERNARDO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**ZUCCARELLO BERNARDO** Monday 10:00 12:00 UFFICIO EDIFICIO 8

DOCENTE: Prof. BERNARDO ZUCCARELLO

PREREQUISITES	Anatomy & Physiology, Biomechanics.
LEARNING OUTCOMES	Technical knowledge Knowledge of mechanical design for biomedical devices Knowledge of main design methods and their limitations, knowledge of main failure mode and related criteria of prediction Applied knowledge Capacity to apply theory and notions to solve real problems, examples include: biomedical device design and assessment, endoprosthesis design, blood oxygenators hemodynamic analysis. Independent thinking and creativity Ability to generate novel ideas and to assess the technical and clinical outcomes of a project/task design variables. Communication skills Ability to address technical/scientific questions properly in a highly structured and technology intensive work environment. Ability to communicate technical/scientific notions properly to the lay audience. Learning skills Capacity to access regenerative medicine scientific literature independently. Capacity to access and understand contents of a biomechanical design "second level" class. Capacity to understand basic tasks and operate on a biomedical engineering laboratory and on a biomechanical test laboratory.
ASSESSMENT METHODS	Students will be evaluated based on a written examination composed of two parts: A) open questions on the course contents randomly selected and covering 20% of the major topics addressed during the frontal teaching and interactive practical sessions. B) numerical problem focusing on notions addressed during the class and particularly during the practical sessions. Each component is scored with a value spanning from 1 to 15. Total maximum mark is therefore equal to 30 and represents the final mark proposed to the student being evaluated. A minimum of 7.5 is required on each component to obtain a pass score. The value on each question is determined based on the student capacity to applied theoretical notions to actual designing tasks such as: biomaterial design, cell culture protocol optimization, biomedical device design. While component A aims to assess the candidate capacity to elaborate and formulate independent ideas based on the class contents, component B aims to verify engineering and analytical skills. Maximum mark of "30/30 e lode" will be utilized only for individuals who will demonstrate both 1) excellent technical knowledge of the course contents, 2) capacity to think independently and communicate/disseminate results efficiently.
EDUCATIONAL OBJECTIVES	The course intends to train the student, so that he is able to solve problems related to the design of biomechanical systems, with particular reference to the devices for musculoskeletal, dental and cardiovascular systems. For the various biomechanical components examined, after a preliminar analysis of the main functional characteristics, the relative design is implemented by considering the mechanical reliability and the fatigue strenght. Particular attention is paid to the technical standards for the mechanical design of biomechanical devices. Some exercitations are carried out to allow the students to know and use the modern approaches for the design of biomechanical components.
TEACHING METHODS	The course includes lectures, exercises, laboratory.
SUGGESTED BIBLIOGRAPHY	Hamrock B.J., Jacobson B., Schmid S.R. "Fundamentals of Machine Elements". McGraw-Hill. Juvinall R.C., Marshek K.M. "Fondamenti della progettazione dei componenti delle macchine". ETS Pisa. Budynas R.G., Nisbett J.K. "Shigley's Mechanical Engineering Design". McGraw Hill Edition.

SYLLABUS

Hrs	Frontal teaching
5	Introduction on the Mechanical and Biomechanical Design: theoretical, numerical and experimental analysis.
5	Technical Standards on the design and the characterization of mechanical and biomechanical components. Tests and Simulators.
8	Damage mechanisms and strenght analysis under static loading: nominal stress, ultimate and allowable stress. Stress Concentration and Fracture Mechnanics elements. Failure Criteria for isotropic and anisotropic materials.
5	Design of biomechanical elements (theory, standards, numerical and experimental simulations)

SYLLABUS

Hrs	Frontal teaching
10	Fatigue Design: introduction, experimental evidences and Wohler diagram. Cyclic loading and Random Fatigue. Parameters influencing the fatigue strenght. Fatigue analysis of biomechanical components. Fatigue tests on biomechanical componets (prothesis, endoprothesys, etc) and relative standars. Fatigue Analysis. Fatigue life. Methods for the cumulative damage analysis. Multiaxial Fatigue. Fatigue design of biomechanical devices.
5	Fatigue design of prothesys (hip, knee etc.) by means of theoretical approach and numerical simulations.
5	Buckling: colums and tubes under external pression.
5	Contact, wear and lubrication. Hrtz theory. Wear models. Wear of articular prothesys.
6	Joints for Biomechanics: screws, rivets, thick-walled cylinders, Morse cone. Design and applications (Morse cone in hip protesys, screws in dental plants, fixers and bioreactors).
4	Part 1: Introduction to mechanical design for biomedical devices, biomedical device classification. Part 2: Fundaments of mechanical joints for biomedical devices.
2	Part 3: Mechanical design with examples: orthopedic prosthesis, dental implants, mechanical heart valve, endovascular stents.
9	Part 4: Mechanical failure modes and prediction criteria for biomedical applications. Part 5: Failure for mechanical instability. Part 6: Fatigue failure and theory for biomedical devices. Part 7: Biomechanical device wear.

Hrs	Practice
6	Mechanical design of biomedical devices.

Hrs	Workshops
6	Biomechanical testing for orthopedic, dental, valve prosthesis.