BME 302 – Mechanical Fundamentals of BME

3 credits, Studio Format- 1 hour lecture, followed by 1-2 hour laboratory; twice per week
Instructor: Eun Jung Lee, Ph.D.

Text book(s)/Materials Required:
Fundamentals of Biomechanics, Ozkaya & Nordin, 2nd Edition
Matlab Programming for Engineers, Stephen J. Chapman, 4th Edition
References: Engineering mechanics Statics, R.C. Hibbeler, 13th Edition

Description:
This course is part of NJIT's four-course introduction to biomedical engineering. It offers an overview of the important areas in the field, as well as providing mechanical fundamentals that provide a critical basis for later learning experiences. This course addresses biomechanics, with an emphasizing on statics & strength of materials, and biofluids. The lecture topics will be reinforced in the studio exercises & labs. This course will give you the opportunity to understand how mechanical engineering principles are applied to physiology and physiopathology (medical problems).

Prerequisites: Grade of C or higher in Phys 121 and Math 112 or Math 133. Co-requisite: Math 279.

Course Learning Outcomes:
The student will be able to explain the significance of current research about a particular topic.

By the end of the course you should be able to do the following:
Physiological Applications: Understand the fundamental principles and physiological applications of biomechanics, biomaterials, bio-fluids, and biostatistics. Apply knowledge of math, engineering and science to identify, formulate, and solve problems in these areas.
Data Interpretation: Learn to utilize Matlab software to analyze data: produce mathematical computation and graphical analysis. Apply knowledge of math, engineering and science to interpret data. Develop an understanding of and develop the skills necessary to communicate findings and interpretations in an effective laboratory report.
Biomechanical Modeling: Apply knowledge of math, engineering and science to understand the principles of biomechanical modeling: *define system*, its key components, significant variables/inputs/outputs, and *describe relationships* in both visual and mathematical forms. Understand how to apply specific models to solve problems in biomechanics, biomaterials and bio-fluids.
Work in Multi-disciplinary teams: Learn to work cooperatively and communicate effectively with peers on teams to attain a common goal, including well-formulated lab reports and a 5-minute oral presentation on learning out comes specific to lab experiment.
Self-Assessment: Identify key areas for growth and assess progress in terms of strengths as well as areas for improvement.

Brief list of topics to be covered:
Statics: Forces, FBD and Vectors
Statics: Equilibrium, Moment, Torque
Biomechanical models; Center of Gravity
Joint & Muscle mechanics; indeterminate systems; solution design
Deformable body mechanics (Axial stress & strain)
Stress and strain: Hooke's law, Poisson ratio
Multiaxial deformations; Stress transformations, principal stresses
Mohr's circle; Failure theories
SF, stress concentration; Torsion and bending moment diagrams
Mechanical properties of Biomaterials
Intro to fluids; Hydrostatic pressure
Poiseuille's law; Laplace's law
Bernoulli's principle; Fluid Flow
Bio-fluid mechanics
Matlab basics

Performance Criteria	**Specific Activity During the Course**	**Assessment Methods/Metrics**
Course Objective 1: Understand the fundamental principles and physiological applications of biomechanics, biomaterials, bio-fluids, and biostatistics**.** Conduct experiments and apply knowledge of math, engineering and science to identify, formulate, and solve problems in these areas.		
A-1 Apply foundations of math, science, engineering to develop solution to problem	Static analyses of various biomechanical systems,	Studio exercises; Exams
E-1 Formulate a potential engineering approach	Analysis of stress and strain of deformable bodies; analysis of problems in biofluids.	Studio exercises; Exams
E-2 Develop suitable solution to BME problem	Analysis of biomaterial properties; application of safety factors and fracture theories	Studio exercises; Exams
B-1 Design and conduct experiments on a problem	Design lab to identify unknown forces/moments for various systems; design lab to identify center of gravity	Laboratory reports
K-2 Use modern technology / instrumentation	Use of proE program to design and print biomaterials	Laboratory report
N-1 Collect data from humans/ N-2 Analyze data from humans	Blood pressure measurements (relavant to bio-fluid principles); anthropometric measurements (relevant to biostatistic principles)	Laboratory reports
Course Objective 2: Learn to utilize Matlab software to analyze data. Apply knowledge of math, engineering and science to interpret data.		
B-2 Properly collect, analyze, & present data	Collect reliable data and present clear and concise graphical data and analyses	Laboratory reports

	in all laboratory experiments.	
K-3 Apply high-level engineering software	Utilize Matlab for biostatistical analyses	Laboratory reports
M-2 Statistically analyze/interpret bio/physio data	Stastical analysis and interpretation of anthropometric measurements (regression and correlation and comparison of means)	Laboratory reports
B-3 Interpret meanings from analyzed data/	Interpret graphical displays of stress and strain of material comparable to biological material; interpret statistical analyses.	Laboratory reports
e Course Objective 3: Apply knowledge of math, engineering and science to understand biomechanical modeling. Understand how to apply specific models to solve problems in the areas of biomechanics, biomaterials and bio-fluids.		
A-1 Apply foundations of math, science, engineering to develop solution to problem/ E-1 Formulate a potential engineering approach	Analysis and application of biomechanical and viscoelastic models	Studio exercises; Exams
B-2 Properly collect, analyze, & present data	Collect data for model application for determining leg center of gravity	Laboratory reports
K-1 Use modern computational methods	Numerical analysis in generating biomechanical model solution	Laboratory report
L-2 Apply bio/physio insight for BME application	Apply elastic and fluid models to further insight to mechanical behaviour of biological materials	Studio exercises and exams
M-1 Model bio- & physiological systems	Apply musculoskeletal models for understanding of stability and motion	Studio exercises and exams
Course Course Objective 4: Learn to work and communicate effectively with peers on multi-disciplinary teams to attain a common goal. Develop an understanding of and develop the skills necessary to communicate findings and interpretations in an effective laboratory report.		
D-1 Work with others & share responsibilities	Collaboration in all studio laboratories and group exercises	Laboratory reports
G-2 Present written communication of tech info/data	Written communication of data and analyses	Laboratory reports