BME110A BIOMECHANICS I

(Required for BME and BMEP; Elective for MSE)

Catalog Data: **BME110A BIOMECHANICS I (Credit Units: 4)** Introduction to continuum mechanics of both living and non-living systems. Laws of motion and free-body diagrams. Stresses, deformation, compatibility conditions, and constitutive equations. Properties of common fluids and solids. Field equations and boundary conditions. Applications to bioengineering design. Prerequisites: Physics 7D, 7LD, 7E. BME110A-B and BMEH110A-B may not both be taken for credit. BME110-A-B-C must be taken in same academic year. (Design units: 1)

Textbook: Fung. Y. C., *A First Course in Continuum Mechanics for Physical and Biological Engineers and Scientists,* 3rd edition, Prentice Hall, New Jersey, 1994.

References: Class notes

Coordinator: Elliot Botvinick

Relationship to Program Outcomes: This course relates to Program Outcomes
BME: a, b, c, e, and k as stated at:
http://undergraduate.eng.uci.edu/degreeprograms/biomedical/mission

Course Outcomes / Performance Criteria: Students will:

Describe the continuum hypothesis. (BME a)
Describe Newton's Laws of motion qualitatively and quantitatively. (BME a)
Express physical laws using index notation. (BME a)
Use free body diagrams to analyze the distribution of forces in a structure. (BME a)
Solve equilibrium problems using resultant forces and moments. (BME a)
Define stress, principal stress, stress deviator, stress boundary conditions and Cauchy's relation. (BME a)
Describe the equation of equilibrium and use it to solve various problems. (BME a)
Define strain, rotations, and spin tensor. (BME a)
Describe the constitutive relation of solid, fluid and gas. (BME a)
Describe the conservation laws: mass, momentum and energy. (BME a).
Define the Reynolds Number. (BME a)
Solve the problem of flow between two parallel channels. (BME a)
Solve the problem of flow in a tube (Poiseuille's equation). (BME a)
Develop simple models of viscoelastic tissues. (BME b)
Use knowledge of continuum mechanics to formulate and solve various other problems of solids and fluids. (Homework and design projects). (BME c, k)
Study existing and design novel biomechanical devices. (BME e)

Prerequisites By Topic: Classical Physics and Lab.
Electricity and magnetism.
Classical Physics: Fluids, oscillations, waves, optics.
Calculus.
Differential Equations.

Lecture Topics: Newton's Laws of Motion; Index Notation; Resultant Forces; Moments; Free Body Diagrams; Orthogonal Transformations; Definition of Stress; Cauchy Relation;

Equation of Equilibrium; Applications of Principal Stresses; Stress Deviator; Stress Boundary Conditions; Infinitesimal strains; Rotations; Spin Tensor; Compatibility; Theory of Deformation; Strain; Strain Rate; Geometric Interpretation; Material Properties; Solids, Fluids, Newtonian Incompressible Fluids, Material Derivatives, Conservation of Mass of a Continuum, Equation of Motion for a Fluid, Navier-Stokes Equations, Non-Dimensionalization, Reynolds Number, Applications: Flow Between Parallel Channels, Flow in a Tube (Poiseuille's Equation).

Class Schedule: Meets for 3 hours of lecture and 1 hour of discussion each week for 10 weeks.

Computer Usage:

Laboratory Projects:

Professional Component: Contributes toward the Biomedical Engineering Topics and Major Design experience.

Design Content Description

Approach: Design is taught through design projects and homework problems. The students are required to use the basic principles to design devices, theoretical approaches and experiments.
Lectures: 100%
Laboratory Portion: 0%

Grading Criteria:

Homework:	20%
Midterm I:	20%
Midterm II:	20%
Final:	40%
	100%

Estimated ABET Category Content:

Mathematics and Basic Science: ___0 credit units or ___0%
Engineering Science: ____3 credit units or ____75%
Engineering Design: ____1 credit units or ___25%

Prepared by: Elliot Botvinick **Date:** July 2008

CEP Approved: Winter 2008