University Of California, Berkeley
Department of Mechanical Engineering

ME C117/Bio Eng C117: Structural Aspects of Biomaterials (4 units)

Undergraduate Elective

Syllabus

CATALOG DESCRIPTION

This course covers the mechanical and structural aspects of biological tissues and their replacements. Tissue structure and mechanical function are addressed. Natural and synthetic load-bearing biomaterials for clinical and medical applications are reviewed. Biocompatibility of biomaterials and host response to structural implants are examined. Quantitative treatment of biomechanical issues and constitutive relationships of tissues and biomaterials are covered. Material selection for load-bearing applications including reconstructive surgery, orthopedics, dentistry, and cardiology. Mechanical design for longevity including topics of fatigue, wear, and fracture. Use of bioresorbable implants and hybrid materials. Directions in tissue engineering. Also listed as Bioengineering C117.

COURSE PREREQUISITES

ME 108 or E45 or permission of the instructor.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Mechanics of Biomaterials: *Fundamental Principles for Implant Design,* Pruitt and Chakravartula, Cambridge University Press, Cambridge, UK, 2011.

COURSE OBJECTIVES

The objective is to provide a systematic coverage of biomechanical properties as they relate to tissues, biomaterials, and devices. these properties include isotropy/anisotropy, stiffness, bending stresses, contact stresses, multiaxial loading, plasticity, fatigue, fracture, wear, corrosion, and mechanical design issues. Case studies in orthopedics, dental, cardiovascular and soft tissue repair are presented.

DESIRED COURSE OUTCOMES

Students should have an understanding of design and structural issues related to medical devices used to restore function to load bearing tissues. Students will also have knowledge of FDA regulatory issues, biocompatibility and sterilization technology for devices and biological materials.

TOPICS COVERED

Overview of biomaterials. Review of cell and tissues, structure-function relationships. Biocompatibility, Foreign Body Response, and Wound Healing. Medical Devices and FDA Regulatory Issues. Synthetic biomaterials and sterilization technology. Review of important mechanical properties. Biomechanical design issues: plastic deformation, fatigue, fracture, wear, corrosion. ORTHOPEDIC TISSUES AND BIOMATERIALS: Structure and function of orthopedic tissues. Mechanisms for damage and disease. Clinical

treatments. CARDIOVASCULAR TISSUES AND BIOMATERIALS: Structure and function of vascular tissue. Etiology of cardiovascular disease. Clinical treatments. Vascular devices. SOFT TISSUE RECONSTRUCTION: Structural Properties, wound healing, stability, biofixation. DENTAL TISSUES AND BIOMATERIALS: Structure and function of dental tissues. Progression of disease. Clinical treatments. Dental materials/restorative materials

CLASS/LABORATORY SCHEDULE

Three hours of lecture and one hour of discussion per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Teamwork: Work in teams on a semester long design project. Communication Skills: Technical write-up and presentation at the end of the semester. Teaching component to middle school children.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. An understanding of professional and ethical responsibility. An ability to communicate effectively. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. A recognition of the need for, and an ability to engage in life-long learning. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

(30%) Project I (Historical evolution of medical devices)
(30%) Project II (Structural analysis, device failures and recalls)
(40%) Project III (Medical device design and clinical issues)

ROOM SHARE & GRADUATE CONTENT:

Both ME C117/BioE C117 and MEC215/BioEC222 will share same lectures. Both will have three design projects. However for MEC215/BioEC222, graduate students will be assigned more extensive project deliverables for their design projects. The graduate requirements will include extensive literature reviews, assessment of intellectual property development, and oral presentation (in additional to a written technical report) of their findings to the class. Undergraduates in ME C117/BioE C117 will have simpler requirements for their design projects.

PERSON(S) WHO PREPARED THIS DESCRIPTION

Professor Lisa Pruitt, October 14, 2011

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): STR ASPT BIOMECH
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Spring
COURSES THAT WILL RESTRICT CREDIT: ME C215 and Bio Eng C222
INSTRUCTOR(S): Pruitt

DURATION OF COURSE: 14 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 12
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: Bio Eng C117