BME 452 - Mechanics and Performance of Biomaterials

3 Credits, 3 Contact hours
Instructor: Bryan Pfister, Ph.D.
Course Coordinator: Bryan Pfister, Ph.D.

Textbook(s)/Materials Required:
Mechanics of Biomaterials, Fundamental Principles for Implant Design by Pruitt and Chakravartula, Cambridge University Press ISBN-13: 9780521762212

Description:
Biomaterials is an interdisciplinary field of material science, engineering, mechanics and biology. Material selection and performance is essential to the mechanical design and implementation of most any biomedical application. Biomaterials must be tolerated by the human body, and are often required to integrate functionally. Students will learn about material selection, important properties of materials for use in the body and failure modes of applied biomaterials. The course will cover structure of materials and how structure defines the behavior of a material. The bulk behavior of materials will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced (including thermal strain, surface properties, and viscoelasticity). Students will be presented with problems of property characterization, failure analysis and performance testing. The process of material selection for biocompatibility will be introduced in regards to body responses including immunological, cell and tissue interaction, toxicity and safety. Students will learn to approach and critically analyze biomaterial problems and applications and assess their clinical applicability, preparing them for both industry and academic research. Students will work in teams to analyze a marketed implant or device using biomaterial(s) using the tools and concepts learned in the course.

Prerequisites:
Math 222, BME 303, BME 304, Mech 320

This is a required course for the Biomechanics Track.

Course Learning Outcomes:

14. Be able to describe the major types of materials that are used in the body and their major modes of failure and describe the relationship between material selection and performance *in vivo*.
15. Be able to define design criteria for a material with relationship to their clinical application and apply material property fundamentals to analyze the performance of a material *in vivo.*
16. Be able to analyze the biocompatibility of medical device designs in regards to device/material function, degradation and toxicity and bodily responses including immunological response, cell/tissue interaction and effects on physiological functions.
17. Be capable of reading, comprehending and communicating the content of contemporary technical articles on biomaterials research and applications.

18. Be able to discuss the broader implications of the design on cultural, ethical, and economic factors.
19. Use knowledge gained to competently interpret current performances of contemporary and novel biomaterials and present recommendations for further study.

Student Outcomes:

Student outcome H - Broad education to understand effect of engineering solutions in a global, economic, environmental, and societal context.
Related CLO - 5

Student outcome J - Knowledge of contemporary issues.
Related CLO – 3, 4, 5, 6

Student outcome L - Apply bio/physio insight for BME application
Related CLO – 1, 2, 3

Student outcome O - Assess safety and effectiveness of interactions between living & non-living.
Related CLO – 1, 2, 3, 4

Topics: The chemical dynamic of living organisms, human cells and cellular dynamics, innate and adaptive immune response, foreign body response, the nature of solids, mechanical properties of materials, viscoelasticity, types of biomaterials: metals, ceramics, natural and synthetic polymers, polymer materials structure, physical behavior, and synthesis, biodegradable materials, medical devices: regulatory affairs and ethics, biomaterials in tissue engineering.