BME 452 - Mechanical Behavior and Performance of Biomaterials

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

Textbook(s)/Materials Required:

Mechanical Behavior of Materials, Norman E. Dowling, Prentice Hall; 4th edition, **ISBN-10:** 0131395068

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 by topic:

BME 302, BME 304, BME 321, and MATH 222, MATH 279
This is a required course for the Biomechanics Track.

Course Learning Outcomes (CLOs):

1. 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*.
2. Be able to mathematically describe how material properties relate to their behavior under loading conditions.
3. Be able to properly apply material properties to calculate material behavior mathematically given constraints and loading conditions.
4. 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.*
5. Be able to calculate probability of failure of a component based on the distribution of material behavior and variability of the loading conditions.
6. Be able to discuss the broader implications of the design on cultural, ethical, and economic factors.
7. Use knowledge gained to competently interpret mechanical performances of contemporary and novel biomaterials and present recommendations for further study.

Student Outcomes:

Student outcome 1 - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Related CLO - 1,2,3,4,5

Student outcome 2 - an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Related CLO – 1,4,6,7

Program Specific Criteria:

B- the capability to apply advanced mathematics (including differential equations and statistics) to solve the problems at the interface of engineering and biology
Related CLO – 2,3,5

C - the capability to apply advanced science and engineering to solve the problems at the interface of engineering and biology
Related CLO – 1,2,3,4,5

E - address problems associated with the interaction between living and non-living materials and systems
Related CLO – 1,4,5,7

Course Topics:

The nature of solids, types of biomaterials: metals, ceramics, natural and synthetic polymers, polymer material structure, physical behavior, mechanical properties of materials, viscoelasticity, failure analysis, failure probability, fatigue, biomaterials in tissue engineering