BMED 3400 Introduction to Biomechanics

Credit: 4-0-4

Prerequisite(s): (MATH 2403 (w/concurrency) or MATH 2413 (w/concurrency)) and COE 2001 (w/minimum grade of "C")

Catalog Description
An introduction to the basic concepts and methods in mechanics, as applied to biological systems, including mechanics of materials and rigid-body dynamics. The biomedical applications of mechanics will be illustrated.

Text
None

Objectives
The overall objective of this course is to provide students the basic concepts, approaches, and biomedical applications of mechanics. Emphasis is placed on teaching students problem-posing and problem-solving skills and illustrating how the fundamentals of mechanics are applied to biological problems.

Outcomes
At the end of the course the students should be able to:

1. Draw free-body diagrams and solve for forces and moments in a musculoskeletal system (Program Outcomes 1 and 2)
2. Obtain stress and strain distributions in bone and other simple structures under tension, compression, torsion and bending (Program Outcomes 1 and 2)
3. Describe the mechanical properties of biological tissues (Program Outcome 1)
4. Apply Newton's laws to predict the motion of rigid particles (Program Outcome 1)
5. Analyze the dynamics of rigid bodies and solve for velocities, acceleration or forces (Program Outcomes 1 and 2)
6. Apply basic mechanics to other biological problems (Program Outcomes 1 and 2)

Topical Outline

1. **Statics Review**
   Application of statics to biomechanics

2. **Mechanics of Materials**
   Axial loading and deformation
   - Normal Stress-Strain relations
   - Hooke's Law**,** Poisson's ratio
   - Axial deflection with distributed loads

- Axial deflection with variable geometry
- Axial loading and failure criteria
- Principle of superposition
- Solving statically indeterminate problems

Torsional loading and deformation

- Shear Stress-Strain relations
- Torsion in circular shafts
- Torsional deflection, failure criteria
- Distributed loads, superposition, static indeterminacy

Bending loading and deformation

- Shear force and bending moment
- Shear and moment diagrams review
- Bending stress in beams
- Shear stress in beams
- The elastic curve and deflection in beams
- Combined loadings
- Principal stresses

3. Dynamics of Rigid Bodies

Linear particle kinematics and kinetics
Free vibration; spring-mass-damper system
Forced vibration
Viscoelastic modeling of biological tissues
Curvilinear particle motion
Kinematics of rigid bodies
Relative velocity
Relative acceleration
Kinetics of rigid bodies
Equations of motion
Energy methods, Impulse and Momentum