BME 451 Biomechanics I

3 Credits
3 Contact hours
Instructor: Namas Chandra, Ph.D., P.E.
Course Coordinator: Namas Chandra, Ph.D., P.E.

Textbook(s)/Materials Optional:

Basic biomechanics of the musculoskeletal system, Fourth Edition, Nordin and Frnakel, **ISBN-978-1-60913-335-1**

Description:

Biomechanics is the application of the principles of mechanics of solids and fluids to the biological systems, specifically humans. The concepts will be used to study the motion and deformation of the various parts of the body under normal, diseased and injured conditions. The relationship between forces at the external level to the deformation at the cellular, tissues, muscular and skeletal levels determine the optimal operations and when injuries occur. Students will be introduced how the concepts of mechanics can be applied to human systems. Students will learn about musculoskeletal behavior, first by studying the biomechanics of bones, cartilages, tendons, ligaments, nerves and skeletal muscles. The course next addresses the biomechanics of various joints including knee, hip, foot, ankle, lumbar spine, shoulders, elbows, wrist and hand. For each case, constitutive equations will be developed at the cellular and structural levels which can be then used to solve the boundary value problem. Various clinical examples of how the normal and injured functions are measured and treated using biomechanics principles will be elucidated.

Prerequisites by topic:
BME 302 and BME 321
This is a required course for the Biomechanics Track.

Course Learning Outcomes (CLOs):

1. Be able to describe the major types of forces and moments applied during normal motion and describe the relationship between forces and deformation.
2. Be able to mathematically describe how body segment and joint behave under loading conditions.
3. Be able to properly apply specific loading configurations to calculate musculoskeletal geometry mathematically given constraints and loading conditions.
4. Be able to define design criteria to prevent specific pathology, e.g. knee failure
5. Be able to calculate probability of failure of a component based on the distribution of loading behavior, gender, age and health status, able to interpret clinical case studies
6. Be able to describe load-loading rate-displacement relationship between different tissues at the structural and sub-structural levels.
7. Use the concept learned to solve real-world biological problems joint failure and treatment procedures.

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 - 1,2,3,6

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 – 3,4,7

Student outcome 5-an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives

Related CLO – 3,6,7

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 – 1,5,6

C - the capability to apply advanced science and engineering to solve the problems at the interface of engineering and biology
Related CLO – 1,2,3,4,7

E - address problems associated with the interaction between living and non-living materials and systems

Related CLO – 1,2,5

Course Topics:

Application of mechanics: tension, compression, bending, torsion, shear and combined loading to musculoskeletal systems, biomechanics of bone, articular cartilage, tendons, ligaments, nerves, and muscles. Case studies of tissue damage due to intrinsic metabolic, vascular and cellular factors and extrinsic mechanical, chemical and disease conditions. Biomechanics of joints including knees, hip, foot, ankle, spine, shoulder and elbows