Approved in 38th BoA Meeting (22-01-2021)

Course Number: BE 301
Course Name:Biomechanics
Credits: 3-0-2-4
Prerequisites: Mechanics of Rigid Bodies (IC 240)
Intended for: B. Tech M.Tech Integrated Dual Degree Bioengineering students
Distribution: Core for Integrated Dual Degree Bioengineering students

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1. **Preamble:**

   The course provides an overview of musculoskeletal anatomy, plant mechanics, the mechanical properties and structural behavior of biological tissues, and bio-dynamics. Specific course topics will include structural and functional relationships in tissues and organs; application of stress and strain analysis to biological tissues; analysis of forces in human function and movement; energy and power in human activity; introduction to modeling viscoelasticity of tissues.

2. **Course modules with Quantitative lecture hours:**

   Theory: **[42 hours]**

   Module I: Introduction and Fundamentals: What is Biomechanics? Anatomical Concepts in Biomechanics, free-body diagrams and equilibrium; linear and angular kinematics, kinetic equation of motion, work and energy method, application to biological systems: stress, strain, Modulus, strain energy, tension, compression, torsion, bending, buckling. [14 hours]

   Module II: Tissues: Animal tissues and plant tissues. Classification of animal tissues - hard tissue, soft tissue, properties of plant and animal tissues according to mechanics view point, Structure, Function, composition, material properties and modeling of tissues, Plant tissues – vascular bundles – xylem and phloem. Continuum Mechanics Concepts in Modeling of large deformation, Finite Element Modeling. [14 hours]

   Module III: Joints and Movements: Classification of joints, forces and stresses, biomechanical analysis joints, Gait, Joint replacement and reasons, Finite Element Modeling. [8 Hours]

   Module IV: Biofluid mechanics: Flow properties of blood and others, Fluid flow in plants, Dynamics of fluid flow in the biological system - modeling and experimental approaches, Measurement/Estimation of In-vivo elasticity of fluid transporting vessels. [6 Hours]

   Lab: **[28 hours]**
   1. To determine the tensile properties of a material (root or bones or plants or others).
   2. To determine the bending properties of a material (root or bones or plants or others).
   3. To determine the hardness properties of a material.

4. To determine the torsional/shear properties of a material (root or bones or plants or others).
5. To determine the buckling properties of amaterial (root or bones or plants or others).
6. To determine the energy absorbed and toughness of amaterial (root or bones or plants or others).
7. To determine the wear properties of material and different combination of material
8. To determine the ground reaction force during normal walking or running.
9. Finite ElementModelling and analysis of hard tissue and soft tissue (examples: Bone, ligaments or muscles)
10. Fluid flow through the cardiovascular system: Simple modelling and analysis

3. Text Books:

(a) Basic Biomechanics of the Musculoskeletal System. M. Nordin&V. H. Frankel, Publisher- Lippincott Williams and Wilkins, 2012.

(b) Biomechanics: Mechanical Properties of Living Tissues. Y. C. Fung, Springer, Second edition, 2007.

4. Reference Book:

(a) Plant Biomechanics: An engineering approach to plant form and function, K. J. Niklas, University of Chicago Press, 1992.

(b) Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, Ozkaya,Nordin, Goldsheyder and Leger. Third edition, Springer, 2014.

(c) Fundamentals of Biomechanics, R. L.Huston, CRC Press, 2013

5. Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approx. % of content
Mechanics of Solids	ME 206	Stress, strain, Modulus, strain energy, tension, compression, torsion, bending, buckling	15 %

6. Justification of new course proposal if cumulative similarity content is >30%:
NA