22MEHO203	FUNDAMENTALS OF BIO-MECHANICS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
1. Basic knowledge of physics and biology which includes kinetics & kinematics.		**PE**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

1.	Explain the principles of mechanics.
2.	Discuss the mechanics of physiological systems.
3.	Explain the mechanics of joints.
4.	Illustrate the mathematical models used in the analysis of biomechanical systems

UNIT I	**INTRODUCTION TO MECHANICS**	**9**	**0**	**0**	**9**

Introduction – Scalars and vectors, Statics – Force types, Resolution and composition of forces, Moments of force and couple, Resultant force determination, pparallel forces in space, equilibrium of coplanar forces, Dynamics - Basic principles – Linear motion, Newton's laws of motion, Impulse and Momentum, Work and Energy. Kinetics – Velocity and acceleration, Kinematics – Link segment models, Force transducers, Force plates, Introduction to Constitutive equations – Constitutive equations of Non-viscous fluid, Newtonian Viscous fluid and Hookean Elastic solid

UNIT II	**BIO-FLUID MECHANICS**	**9**	**0**	**0**	**9**

Intrinsic fluid properties – Density, Viscosity, Compressibility and Surface Tension, Viscometers – Capillary, Coaxial cylinder and cone and plate, Rheological properties of blood, Pressure-flow relationship for Non-Newtonian Fluids, Fluid mechanics in straight tube – Steady Laminar flow, Turbulent flow, Flow development, Viscous and Turbulent Sheer Stress, Effect of pulsatility, Boundary Layer Separation, Structure of blood vessels, Material properties and modeling of Blood vessels, Heart – Cardiac muscle characterization, Native heart valves – Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics.

UNIT III	**BIO-SOLID MECHANICS**	**9**	**0**	**0**	**9**

Constitutive equation of viscoelasticity – Maxwell & Voight models, anisotropy, Hard Tissues – Structure, blood circulation, elasticity and strength, viscoelastic properties, functional adaptation, Soft Tissues – Structure, functions, material properties and modeling of Soft Tissues – Cartilage, Tendons and Ligaments Skeletal Muscle – Muscle action, Hill's models, mathematical modeling, Bone fracture mechanics, Implants for bone fracture

UNIT IV	**BIO-MECHANICS OF JOINTS**	**9**	**0**	**0**	**9**

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.

UNIT V	**MODELING AND ERGONOMICS**	**9**	**0**	**0**	**9**

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics – Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Whole body vibrations, Hand transmitted vibrations.

TOTAL(45L) : 45 PERIODS

TEXT BOOKS:

1.	Y.C. Fung, "Bio-Mechanics- Mechanical Properties of Tissues", Springer-Verlag, 1998.
2.	Subrata Pal, "Textbook of Biomechanics", Viva Books Private Limited, 2009.

REFERENCES:

1.	Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, "Biofluid Mechanics: The Human Circulation",

	Taylor and Francis, 2007.
2.	Sheraz S. Malik and Shahbaz S. Malik, "Orthopaedic Biomechanics Made Easy", Cambridge University Press, 2015.
3.	Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science Business Media, 2004.
4.	Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press 2007.
5.	Neil J. Mansfeild, "Human Response to Vibration", CRC Press, 2005.
6.	Carl J. Payton, "Biomechanical Evaluation of movement in sports and Exercise", 2008
7.	NPTEL :: Mechanical Engineering - NOC:Biomechanics of Joints and Orthopaedic Implants

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Understand the fundamentals of mechanics and its application in human system.	Understand
CO2	Understand the principles of bio-fluid dynamics and its application in human system.	Understand
CO3	Understand the fundamentals of bio-solid mechanics.	Understand
CO4	Analyze the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.	Analyze
CO5	Give Examples of computational mathematical modelling applied in Bio-mechanics.	Analyze

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	0	0	0	0	0	0	1	0	2	2	0
CO2	2	2	2	2	0	0	0	0	0	0	1	0	2	2	0
CO3	2	2	2	2	0	0	0	0	0	0	1	0	2	2	0
CO4	2	2	2	2	0	0	0	0	0	0	1	0	2	2	0
CO5	2	2	2	2	2	0	0	0	0	0	1	0	2	2	0
Avg	**2**	**2**	**2**	**2**	**0.4**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**2**	**0**

3/2/1 – indicates strength of correlation (3 – high, 2- medium, 1- low)