II B. Tech – II Semester

(20ME4760) BIOMECHANICS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
30	70	100	3	-	-	3

Pre-Requisites: Engineering mechanics, Human anatomy

Course Objective:

The student should be made to:

- Explain the principles of mechanics.
- Discuss the mechanics of physiological systems.
- Explain the mechanics of joints.
- Illustrate the mathematical models used in the analysis of biomechanical systems

UNIT- I: Foundations of Human Movement:

Basic movement terminology - Biomechanics vs Kinesiology - Anatomy Vs Functional Anatomy - Linear Vs Angular motion - Kinematics Vs Kinematics - Statics Vs Dynamics - Anatomical movement descriptors - Segment names - Anatomical names - Movement description - Basic movements - Specialised movement descriptors - Reference systems - Example of Joint movement characteristics Mathematical overview - UNITs of measurements - Vector analysis - Coordinate systems. Forces and moments - Muscle forces Statics - Newton's laws - Solving problems - Simple musculoskeletal problems - Advance musculoskeletal problems Kinematics - Rotational and Translational motion - Displacement, Velocity and acceleration Kinetics - Inertial forces - Work Energy and power - Friction

UNIT- II:

Biomechanics of Joints Classification of Motion - Classification of joints - Factors influencing motion at a joint - The effect of joint structure or joint motion - External forces on a joint - Interaction between joints and the external environment. Biomechanics of Cartilage: Mechanical behaviour and modelling - Material properties - Relationship between mechanical properties and composition - Mechanical failure of cartilage - Joint lubrication - Models of Osteoarthrosis

UNIT- III: Biomechanics of Skeletal Muscle:

Structure of an individual muscle fibre - The connective tissue system within the muscle belly Factors that influence a muscles ability to produce a motion - Effect of fibre length on joint excursion Factors that influence a muscle strength - Muscle size and its effect on force production - Relationship between force production and instantaneous muscle length - Relationship between a muscles moment arm and its force production - Relationship between force production and contraction velocity - Relationship between force production and level of recruitment of motor UNITs within the muscle - Relationship between force production and fibre type. Structure of connective tissue - composition of tendons and ligaments Mechanical properties - determination of stress and strain, stress - strain curve for tendons and ligaments - modes of failure - effects of physical conditions on mechanical properties - biological effects on mechanical properties Response of tendons and ligaments to immobilisations - immobilisation and remobilisation of normal connective tissue - immobilisation and mobilisation in healing connective tissue Response of tendons and ligaments to stress enhancement Skeletal considerations for movement - Functions of skeletal system - Levers - Support - Types of Bones - Biomechanical characteristic of Bones - Bone tissue - Architecture of Bone - Strength and stiffness of Bone - Types of load - Bonny articulations - Diarthrodial/Synovial joint - Types of Diarthrodial/Synovial joint and other types of joints.

UNIT- IV: Functional Anatomy:
The Upper Extremity - Introduction - The shoulder complex - The elbow and radioulnar joints - The wrist and fingers The Lower Extremity - The pelvic and hip complex - The knee joint - The ankle and foot. The trunk - The vertebral column - Cervical region - Thoracic region - Lumbar region - Combined movement of pelvis and trunk - Posture - Conditioning - Contribution of trunk muscles to Sports Skills or movements.

UNIT- V:
Mechanical Analysis of Human Motion: Linear kinematics - Linear kinematic analysis - Position and displacement - Velocity and speed - Acceleration - Differentiation and integration - Kinematics of running - Kinematics of projectiles - Equations of constant acceleration. Angular kinematics - Angular motion - Measurements of angles - Types of angles - Representation of Angular motion vectors - Lower extremity joint angles - Relationship between angular and linear motion - Angular kinematics of running. Linear kinetics - Force - Laws of motion - Types of Forces - Representation of Forces acting on a system - Forces occurring along a curved path - Special force applications. Angular Kinetics - Torque - Centre of mass - Rotation and leverage - Moment of inertia - Angular momentum - Angular analogs to Newtons laws of motion - Special torque applications.

Course Outcome:
At the end of the course, the student should be able to:

S. No	Course Outcome	BTL
CO1	illustratre the principles of biomechanics	L2
CO2	outline the principles of biofluid dynamics.	L2
CO3	explain the fundamentals of bio-solid mechanics.	L2
CO4	apply the knowledge of joint mechanics.	L2
CO5	show examples of computational mathematical modelling applied in biomechanics.	L2

Correlation of Cos with POs & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	1	1	2	1	1	3	3	2
CO2	3	3	3	3	3	3	1	1	2	1	1	3	2	2
CO3	3	3	3	3	3	3	1	1	1	1	1	3	3	1
CO4	3	3	3	3	3	3	1	1	1	1	1	3	3	2
CO5	3	3	3	3	3	3	1	1	1	1	1	3	3	2

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.