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DHANALAKSHMI SRINIVASAN
INSTITUTE OF TECHNOLOGY
(Approved by AICTE, New Delhi & Affiliated to Anna University)
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COURSE PLAN

Subject code: BM8651	**Branch/Year/Sem/Section: B.E BME/III/VI**
Subject Name: BIO MECHANICS	**Batch:2017-2021**
Staff Name: R.NISHANTHINI	**Academic year:2019-2020**

COURSE OBJECTIVE

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

TEXT BOOK:

T1 Y.C. Fung, —Bio-Mechanics- Mechanical Properties of Tissues||, Springer-Verlag, 1998.

T 2. Subrata Pal, —Textbook of Biomechanics||, Viva Books Private Limited, 2009.

REFERENCES:

R1. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, —Biofluid Mechanics: The Human Circulation||, Taylor and Francis, 2007.

R2. Sheraz S. Malik and Shahbaz S. Malik, —Orthopaedic Biomechanics Made Easy||, Cambridge University Press, 2015.

R 3. Jay D. Humphrey, Sherry De Lange, —An Introduction to Biomechanics: Solids and Fluids, Analysis and Design||, Springer Science Business Media, 2004.

R4. Shrawan Kumar, —Biomechanics in Ergonomics||, Second Edition, CRC Press 2007.

R 5. Neil J. Mansfeild, —Human Response to Vibration||, CRC Press, 2005.

R6. Carl J. Payton, —Biomechanical Evaluation of movement in sports and Exercise||, 2008.

WEB RESOURCES

W1: https://www.webopedia.com/DidYouKnow/Hardware_Software/mobile-operating-systems-mobile-os-explained.html (TOPIC NO: 43)
W2: https://www.techotopia.com/index.php/IOS_6_Architecture_and_SDK_Frameworks
(TOPIC NO: 44)
W3: https://developer.apple.com/library/archive/documentation/MacOSX/Conceptual/OSX_Technology_Overview/CoreOSLayer/CoreOSLayer.html (TOPIC NO: 45)

TEACHING METHODOLOGIES:

- BB - BLACK BOARD
- VIDEO - VIDEO TUTORIAL
- PPT - POWER POINT PRESENTATION

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DEPARTMENT OF BIOMEDICAL ENGINEERING

BM8651 BIOMECHANICS L T P C
3 0 0 3

UNIT I - INTRODUCTION TO MECHANICS 9

Introduction – Scalars and vectors, Statics – Force types, Resolution and composition of forces, Moments of force and couple, Resultant force determination, parallel 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 Nonviscous fluid, Newtonian Viscous fluid and Hookean Elastic solid

UNIT-II BIOFLUID MECHANICS 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 characterisation, Native heart valves – Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics.

UNIT-III BIOSOLID MECHANICS 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 fractures

UNIT- IV BIOMECHANICS OF JOINTS 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

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: 45 PERIODS

Topic No	Topic Name	Books For reference	Page No	Teaching Methodology	No of periods required	Cumulative periods
UNIT I	**INTRODUCTION TO MECHANICS**					**(9)**
1.	Introduction , Scalars and vectors, Statics ,Force types, Resolution and composition of forces,			BB	1	1.
2.	Moments of force and couple, Resultant force determination			BB	1	2.
3.	parallel forces in space, equilibrium of coplanar forces, Dynamics			BB	1	3.
4.	Basic principles ,Linear motion, Newton's laws of motion,			BB	1	4.
5.	Work and Energy Kinetics ,Velocity and acceleration			BB	1	5.
6.	Kinematics ,Link segment models,			BB	1	6.
7.	Force transducers, Force plates, Introduction to Constitutive			BB	1	7.
8.	Constitutive equations of Nonviscous fluid			BB	1	8.
9.	Newtonian Viscous fluid and Hookean Elastic solid			BB	1	9.
LEARNING OUTCOME: **At the end of unit , the students will be able to** • Know the fundamentals of mechanics . • Understand the concept of kinetics & kinematics. • Define the types of fluids.						
UNIT II	**BIOFLUID MECHANICS**					**(9)**
10.	Intrinsic fluid properties – Density, Viscosity, Compressibility and Surface Tension, Viscometers			BB	1	10.
11.	Capillary, Coaxial cylinder and cone and plate, Rheological properties of blood			BB	1	11.

12.	Pressure-flow relationship for Non-Newtonian Fluids, Fluid mechanics in straight tube			BB	1	12.
13.	Steady Laminar flow, Turbulent flow, Flow development, Viscous and Turbulent Sheer Stress,			BB	1	13.
14.	Effect of pulsatility, Boundary Layer Separation, Structure of blood vessels,			BB	1	14.
15.	Material properties and modeling of Blood vessels, Heart			BB	1	15.
16.	Cardiac muscle characterisation, Native heart valves			BB & VIDEO	1	16.
17.	Mechanical properties and valve dynamics			BB	1	17.
18	Prosthetic heart valve fluid dynamics.			BB	1	18

LEARNING OUTCOME:

At the end of unit , the students will be able to

- Understand the concept of fluid mechanics.
- Define steady flow.
- Gain the knowledge about bio fluid mechanics.

UNIT – III	**BIOSOLID MECHANICS**				**(9)**
19	Constitutive equation of viscoelasticity		BB	1	19
20	Maxwell &Voight models, anisotropy, Hard Tissues		BB	1	20
21	Structure, blood circulation, elasticity and strength		BB	1	21
22	viscoelastic properties, functional adaptation		BB	1	22
23	Soft Tissues, Structure, functions, material properties and modeling of Soft Tissues		BB	1	23
24	Cartilage, Tendons and Ligaments Skeletal Muscle		BB	1	24

25	Muscle action,			BB	1	25
26	Hill's models, mathematical modeling,			BB	1	26
27	Bone fracture mechanics, Implants for bone fractures.			BB	1	27

LEARNING OUTCOME:

At the end of unit , the students will be able to

- Understand the concept of bio solid mechanics.
- Gain knowledge about muscle action.
- Define viscoelastic properties.

UNIT IV	**BIOMECHANICS OF JOINTS**					**(9)**
28	Skeletal joints, forces and stresses in human joints,			BB	1	28
29	Analysis of rigid bodies in equilibrium,			BB & VIDEO	1	29
30	Free body diagrams,			BB	1	30
31	Structure of joints, Types of joints			BB	1	31
32	Biomechanical analysis of elbow, shoulder,			BB	1	32
33	Biomechanical analysis of spinal column, hip, knee and ankle			BB	1	33
34	Lubrication of synovial joints			BB	1	34
35	Gait analysis			BB	1	35
36	Motion analysis using video			BB	1	36

LEARNING OUTCOME:

At the end of unit , the students will be able to

- Understand the concept of mechanism of joints.
- Known about gait analysis.
- Get the knowledge about joints and its structure.

UNIT V	**MODELING AND ERGONOMICS**					**(9)**
37	Introduction to Finite Element Analysis			BB	1	37
38	finite element analysis of lumbar spine			BB	1	38

39	Ergonomics			BB	1	39
40	Musculoskeletal disorders			BB	1	40
41	Ergonomic principles contributing to good workplace design			BB	1	41
42	Design of a Computer work station			BB	1	42
43	Whole body vibrations			PPT	1	43
44	Hand transmitted vibrations			PPT	1	44
45	Importance of hand transmitted vibration			BB	1	45
LEARNING OUTCOME: **At the end of unit , the students will be able to understand modeling & ergonomics.**						

COURSE OUTCOME

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

- Understand the principles of mechanics
- Outline the principles of biofluid dynamics.
- Explain the fundamentals of bio-solid mechanics.
- Apply the knowledge of joint mechanics.
- Give Examples of computational mathematical modelling applied in biomechanics.

CONTENT BEYOND THE SYLLABUS

- Sports and injury mechanics

CONTINUES INTERNAL ASSESSMENT DETAILS

ASSESMENT NUMBER	I	II	MODEL
TOPIC NO.(UNIT)	1-18(1st & 2nd units)	19-36 (3rd & 4th units)	1-45 (units 1-5)

ASSIGNMENT DETAILS

ASSIGNMENT NUMBER	I	II	III
TOPIC NUMBER FOR REFERENCE	1-18(1st & 2nd units)	19-39 (3rd & 4th units)	1-45 (units 1-5)
DEAD LINE			

ASSIGNMENT NUMBER	BATCH	DESCRIPTIVE QUESTIONS/TOPIC (Minimum of 8 Pages)
I	60 members	• Kinetics and kinematics of motion • Rheological properties of blood
II	60 members	• Viscoelastic properties • Structure of joints, Types of joints
III	60 members	• Finite element analysis