SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF MEDICAL ELECTRONICS

QUESTION BANK

VI SEMESTER - MDE

1910603 – BIOMECHANICS

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Prepared by

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SUBJECT : 1910603 BIOMECHANICS

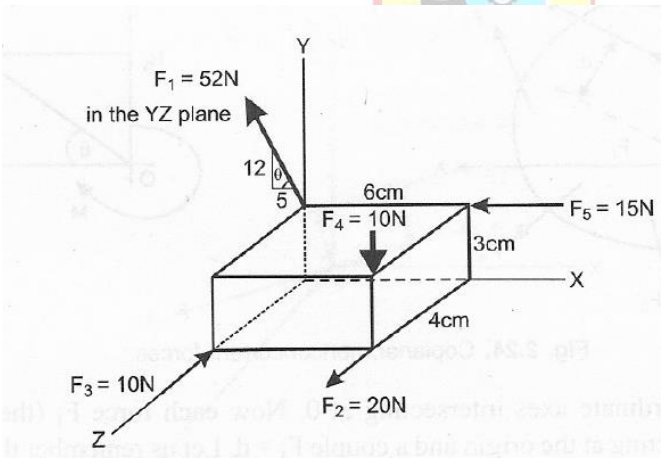
SEM / YEAR : VI / III

UNIT I – INTRODUCTION TO MECHANICS

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

PART – A

Q.No	Questions	BT Level	Competence
1.	Classify the types of forces. State its causes.	BTL 2	Understanding
2.	Why do we need constitutive equation?	BTL 1	Remembering
3.	List the important divisions of dynamics.	BTL 1	Remembering
4.	Define concurrent and non-concurrent forces.	BTL 1	Remembering
5.	Outline the concept of linear motion.	BTL 2	Understanding
6.	Differentiate kinetics and kinematics.	BTL 4	Analyzing
7.	Summarize the applications of biomechanics.	BTL 3	Applying
8.	Give some examples of scalar and vector quantity.	BTL 1	Remembering
9.	State the conditions of equilibrium.	BTL 1	Remembering
10.	Interpret the three Newtons' laws of motion.	BTL 2	Understanding
11.	Write scalar and vector quantity in terms of biomechanics.	BTL 4	Analyzing
12.	What is meant by velocity and acceleration?	BTL 1	Remembering
13.	Outline the importance of work, power and energy.	BTL 5	Evaluating
14.	Compare stress and strain.	BTL 3	Applying
15.	Calculate the force acting on a body of mass 1.0 kg is falling with an acceleration of $10 m/s^2$.	BTL 6	Creating
16.	Assess the meaning of center of gravity.	BTL 5	Evaluating
17.	Distinguish between resolution and composition of forces.	BTL 4	Analyzing
18.	Identify and state the law used in Hookean elastic solid.	BTL 3	Applying
19.	Mention the parameters required to characterize the force.	BTL 2	Understanding
20.	A 200N force accelerates the scooter at 3.0 m/s^2. Determine the mass of scooter.	BTL 6	Creating

PART B			
1.	What is biomechanics? Explain the different forces that acts on the body. (13)	BTL 1	Remembering
2.	Illustrate the following in detail. (i) Scalar quantity. (6) (ii) Vector quantity. (7)	BTL 2	Understanding
3.	Explain Newtons law and give necessary example relating to the physiological system. (13)	BTL 3	Applying
4.	Elaborate in detail about the resolution and composition of forces. (13)	BTL 6	Creating
5.	Express the velocity and acceleration with suitable diagram. (13)	BTL 3	Applying
6.	Write briefly on vector method for resultant force determination. (13)	BTL 1	Remembering
7.	Derive the constitutive equations of non-viscous fluid. (13)	BTL 6	Creating
8.	Discuss the motion of viscous fluid and derive Navier stokes equation. (13)	BTL 4	Analyzing
9.	Explain in detail about the motion mechanics. (13)	BTL 4	Analyzing
10.	What are the special foci of kinetic and kinematic analyses with suitable examples?	BTL 5	Evaluating
11.	Write short notes on parallel forces in space. (13)	BTL 1	Remembering
12.	Summarize the moments of force and couple. (13)	BTL 2	Understanding
13.	Describe the term linear motion used to indicate the motion of points or particles. (13)	BTL 2	Understanding
14.	Discuss briefly about the Hookean Elastic solid. (13)	BTL 4	Analyzing
PART C			
1.	A rectangular body is subjected to forces as shown in figure. Find the resultant of the forces. (15) 	BTL 5	Evaluating
2.	Summarize about the Newtonian viscous fluid with necessary equation. (15)	BTL 5	Evaluating
3.	Explain in detail about the link segment model in kinematics. (15)	BTL 6	Creating
4.	Elaborate in detail the Newtons law of motion. (15)	BTL 6	Creating

UNIT II – BIOFLUID MECHANICS

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.

PART – A

Q.No	Questions	BT Level	Competence
1.	What are heart sounds?	BTL 1	Remembering
2.	How is shear stress developed in laminar and turbulent fluid flow?	BTL 1	Remembering
3.	Differentiate viscometer and rheometer.	BTL 4	Analyzing
4.	Compile the signs of worsening heart failure.	BTL 6	Creating
5.	Summarize the applications of viscosity.	BTL 3	Applying
6.	Define Viscosity.	BTL 1	Remembering
7.	Sketch the structure of heart.	BTL 2	Understanding
8.	List the four types of heart valves. Give their functions.	BTL 1	Remembering
9.	Identify the other name of surface tension.	BTL 2	Understanding
10.	Interpret the most common symptoms of heart valve disease.	BTL 3	Applying
11.	Classify the different types of viscometer.	BTL 4	Analyzing
12.	Name the three physical properties of fluid.	BTL 1	Remembering
13.	Draw the typical pressure and flow curves for the left heart.	BTL 5	Evaluating
14.	Construct the graph of some abnormal cardiac patterns.	BTL 5	Evaluating
15.	Discuss the advantages of artificial heart valves.	BTL 6	Creating
16.	What are systolic and diastolic pressure?	BTL 3	Applying
17.	Distinguish between cohesion and surface tension.	BTL 4	Analyzing
18.	Outline the different methods of preventing the separation of boundary layer.	BTL 2	Understanding
19.	Mention the different types of heart sounds.	BTL 2	Understanding
20.	How does a Couette viscometer work?	BTL 1	Remembering

PART B

1.	What is Cardiac cycle? Explain it with neat graph. (13)	BTL 1	Remembering
2.	Illustrate the following in detail. (i) Density. (6) (ii) Viscosity. (7)	BTL 2	Understanding
3.	With neat diagram explain how viscosity is measured using Poiseuille law. (13)	BTL 6	Creating
4.	A patient has a stenotic aortic valve producing a pressure drop between the left ventricle and the aorta. The mean velocity in the left ventricle proximal (upstream) to the valve is 1 m/s while the mean velocity in the aorta distal (downstream) of the valve is 4 m/s. Applying Equation $p_1-p_2=4v_2^2$, determine the pressure drop across the valve (13)	BTL 5	Evaluating
5.	Explain in detail about the cardiovascular system. (13)	BTL 2	Understanding
6.	Write a briefly on structural components of the blood vessel wall .(13)	BTL 2	Understanding
7.	Derive the pressure flow relationship for non-Newtonian fluids. (13)	BTL 1	Remembering

8.	Discuss in detail about mechanical heart valves. . (13)	BTL 4	Analyzing
9.	Explain in detail about the Rheological properties of blood. (13)	BTL 1	Remembering
10.	Write brief notes on the following (i) Compressibility (7) (ii) Surface tension (6)	BTL 1	Remembering
11.	Write short notes on cone and plate viscometer. (13)	BTL 3	Applying
12.	Summarize and derive the capillary viscometer with necessary equation. (13)	BTL 3	Applying
13.	Describe the material behavior of blood vessels. (13)	BTL 4	Analyzing
14.	Discuss briefly about Laminar flow. (13)	BTL 4	Analyzing
PART C			
1.	Discuss in detail about the electrical activities of the heart. (15)	BTL 5	Evaluating
2.	Explain in detail about the cardiac output. (15)	BTL 5	Evaluating
3.	Elaborate in detail about the vascular mechanics. (15)	BTL 6	Creating
4.	Describe the following in detail (i) Conduction system of the heart (8) (ii) Heart sounds (3) (iii) Heart rate (4)	BTL 6	Creating

UNIT III – BIOSOLID MECHANICS

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..

PART – A

Q.No	Questions	BT Level	Competence
1.	Summarize the signs of poor blood circulation.	BTL 2	Understanding
2.	List the functions of skeletal muscle.	BTL 1	Remembering
3.	Define anisotropy.	BTL 1	Remembering
4.	Name any four types of soft tissues.	BTL 1	Remembering
5.	Give some examples of viscoelasticity.	BTL 2	Understanding
6.	Difference viscoelastic and viscoelastic.	BTL 4	Analyzing
7.	What is the major difference between Maxwell and kelvin Voigt model of elasticity?	BTL 3	Applying
8.	How do you treat poor blood circulation?	BTL 1	Remembering
9.	State ligament and its functions?	BTL 1	Remembering
10.	Classify the types of blood circulation.	BTL 2	Understanding
11.	Write some of the causes of poor circulation.	BTL 4	Analyzing
12.	Why is it advantageous for bone to be anisotropic?	BTL 1	Remembering
13.	Outline the functions of hard tissue.	BTL 3	Applying
14.	Asses the meaning of viscoelasticity.	BTL 6	Creating
15.	Compile the properties that are affected by anisotropy.	BTL 6	Creating
16.	Draw the element of Maxwell model.	BTL 5	Evaluating
17.	Distinguish between hard and soft tissues.	BTL 4	Analyzing

18.	Identify the other name of hard tissue and list some of the hard tissue of human.	BTL 3	Applying
19.	Mention the four functions of circulatory system.	BTL 2	Understanding
20.	Draw the schematic of kelvin voigt model.	BTL 5	Evaluating
	PART B		
1.	How the cartilages are classified? Explain its composition mechanical properties. (13)	BTL 1	Remembering
2.	Illustrate and explain the structure and functions of soft tissues. (13)	BTL 2	Understanding
3.	Demonstrate Hill three element model and derive necessary equation. (13)	BTL 3	Applying
4.	Generalize important points about the different types of Viscoelastic model. (13)	BTL 6	Creating
5.	Explain the mechanical properties of bone. (13)	BTL 3	Applying
6.	Give a detailed account of kelvin model. (13)	BTL 1	Remembering
7.	Draw the stress-strain diagram of various materials and explain. (13)	BTL 6	Creating
8.	(i)Discuss briefly about the viscoelasticity. (7) (ii) Write short notes on mathematical modeling. (6)	BTL 4	Analyzing
9.	Elaborate in detail about the bone fracture mechanism. (13)	BTL 5	Evaluating
10.	Describe the mechanical properties of cartilage. (13)	BTL 4	Analyzing
11.	Write short notes on (i) Maxwell model (7) (ii) Voight model (6)	BTL 1	Remembering
12.	Explain in detail about the functional adaptation of bone. (13)	BTL 2	Understanding
13.	Summarize in detail about the hard tissues. (13)	BTL 2	Understanding
14.	Describe in detail about (i) Tendons (7) (ii) Ligaments (6)	BTL 4	Analyzing
	PART C		
1.	Explain in detail about the viscoelastic properties of bone. (15)	BTL 5	Evaluating
2.	Draw the bone structure and explain the mechanical properties of bone. (15)	BTL 5	Evaluating
3.	Elaborate in detail about the skeletal muscle. (15)	BTL 6	Creating
4.	Describe the material characterization of cardiac muscle. (15)	BTL 6	Creating

UNIT IV – BIOMECHANICS OF JOINTS

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.

PART – A

Q.No	Questions	BT Level	Competence
1.	Classify the types of joints in the structural classification.	BTL 2	Understanding
2.	Which are Synovial joints?	BTL 1	Remembering
3.	Outline the two conditions must be met for an object to be in equilibrium.	BTL 2	Understanding
4.	How accurate is gait analysis?	BTL 1	Remembering

5.	Why spinal column is important for human movement?	BTL 1	Remembering
6.	Examine the purpose of free body diagram.	BTL 4	Analyzing
7.	Interpret the different treatment to relieve pain in back of knee.	BTL 3	Applying
8.	What is joint stress?	BTL 1	Remembering
9.	Name the six types of synovial joints.	BTL 1	Remembering
10.	Describe the functions of hip joint.	BTL 2	Understanding
11.	Differentiate movement and locomotion?	BTL 4	Analyzing
12.	Define joint force analysis.	BTL 1	Remembering
13.	Summarize conditions that are used to analyze the equilibrium problems of rigid bodies.	BTL 5	Evaluating
14.	Identify the most used joint in the body.	BTL 3	Applying
15.	Predict the other name for knee joint and define it.	BTL 6	Creating
16.	Asses the importance of a free body diagram in vector addition.	BTL 5	Evaluating
17.	Point out the functions of the elbow.	BTL 4	Analyzing
18.	Compare hip and pelvis.	BTL 3	Applying
19.	Give an example for joint reaction force.	BTL 2	Understanding
20.	Compile the seven movements of the shoulder.	BTL 6	Creating
	PART B		
1.	Describe in detail about the biomechanical analysis of elbow. (13)	BTL 1	Remembering
2.	Discuss in detail about kinematics of knee joints. (13)	BTL 2	Understanding
3.	Identify the various spatial and temporal feature involved in Gait analysis. Describe about them. (13)	BTL 3	Applying
4.	Elaborate the various methods of fixation of implant. (13)	BTL 6	Creating
5.	Express the detailed view on mechanics of ankle joint. (13)	BTL 3	Applying
6.	What is Gait analysis? Explain the procedure for gait analysis. (13)	BTL 1	Remembering
7.	Explain about the materials and designs involved in making total hip joint and elaborate its fixing procedures. (13)	BTL 6	Creating
8.	Describe in detail about (i) Composition and functions of bone (7) (ii) Mechanical testing of bone tissue (6)	BTL 4	Analyzing
9.	Explain in detail about the lubrication of synovial joints. (13)	BTL 5	Evaluating
10.	Categorize the various movement of joints. (13)	BTL 4	Analyzing
11.	Write brief note on human joint forces. (13)	BTL 1	Remembering
12.	Summarize the biomechanical analysis of spinal column in detail. (13)	BTL 2	Understanding
13.	Illustrate and explain the movements and mechanics of shoulder joints. (13)	BTL 2	Understanding
14.	Analyze the biomechanical system using finite element method. (13)	BTL 4	Analyzing
	PART C		
1.	Draw the free body diagram of a car in motion. Explain in detail about the conditions of equilibrium with appropriate examples. (15)	BTL 5	Evaluating
2.	Explain the composition and mechanical properties of bone. (15)	BTL 5	Evaluating
3.	Describe the mechanics of elbow joint with illustrations. (15)	BTL 6	Creating
4.	Elaborate in detail about motion analysis using video. (15)	BTL 6	Creating

UNIT V – MODELING AND ERGONOMIC			
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.			
PART – A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	How long does it take lumbar strain to heal?	BTL 1	Remembering
2.	Compare workstation and personal computer.	BTL 4	Analyzing
3.	Mention the five aspects of ergonomics.	BTL 2	Understanding
4.	Why is the lumbar vertebrae important?	BTL 1	Remembering
5.	Asses the meaning of HAVS.	BTL 3	Applying
6.	Name the three phases of finite element method.	BTL 1	Remember
7.	Distinguish between FEM and FEA.	BTL 2	Understanding
8.	Identify the methods that are generally associated with the finite element analysis.	BTL 3	Applying
9.	Examine the three primary ergonomic risk factors.	BTL 4	Analyzing
10.	Define finite element analysis.	BTL 1	Remembering
11.	Classify the five aspects of ergonomics.	BTL 2	Understanding
12.	What is computer work station?	BTL 1	Remembering
13.	Write the three basic characteristics measured in vibration.	BTL 1	Remembering
14.	Interpret the meaning of lumbar spine.	BTL 3	Applying
15.	Discuss the main symptoms of hand arm vibration syndrome?	BTL 6	Creating
16.	Outline the causes and effect of vibration.	BTL 5	Evaluating
17.	Give an example of ergonomics.	BTL 2	Understanding
18.	List the most common ergonomic injuries in the workplace.	BTL 4	Analyzing
19.	Compile the impressive benefits of ergonomics in workplace.	BTL 6	Creating
20.	Summarize the parts of the body that can be affected by musculoskeletal disorders.	BTL 5	Evaluating
PART B			
1.	Describe in detail about the biomechanical aspects of sitting postures. (13)	BTL 1	Remembering
2.	Illustrate the characteristics of vibration waveforms. (13)	BTL 2	Understanding
3.	Demonstrate the basic principle of ergonomics and explain in detail. (13)	BTL 3	Applying
4.	Discuss about the health effects of whole-body vibration. (13)	BTL 6	Creating
5.	Express the detailed view on Ergonomics. (13)	BTL 3	Applying
6.	What is finite element analysis? Explain any one analysis of biomechanical systems using FEM. (13)	BTL 1	Remembering
7.	Elaborate in detail on Hand transmitted vibrations. (13)	BTL 6	Creating
8.	Discuss briefly about common injuries and symptoms associated with ergonomically incorrect computer stations. (13)	BTL 4	Analyzing
9.	Analyze the biomechanical system using Finite element analysis method. (13)	BTL 4	Analyzing
10.	Explain in detail about the whole-body response to vibration and shocks (13)	BTL 5	Evaluating
11.	Write brief note on the procedure followed in designing the computer workstation.	BTL 1	Remembering

12.	(i) Write short notes on Musculoskeletal disorder. (7) (ii) Discuss the ways to reduce the Musculoskeletal disorder. (6)	BTL 2	Understanding
13.	Summarize about the control measures for whole body vibration. (13)	BTL 2	Understanding
14.	Design a suitable computer workstation to avoid the musculoskeletal disorder. . (13)	BTL 4	Analyzing
	PART C		
1.	Discuss about the effect of mechanical vibrations in human. (15)	BTL 5	Evaluating
2.	Explain in detail about Finite element analysis. (15)	BTL 5	Evaluating
3.	Describe the ergonomic principles contributing to the good workplace design. (15)	BTL 6	Creating
4.	Elaborate in detail about the measurement of whole-body vibrations. (15)	BTL 6	Creating