Reg.No.:												

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]
Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

Question Paper Code: 120007

B.E. / B.Tech. DEGREE END-SEMESTER EXAMINATIONS – NOV. / DEC. 2025
Seventh Semester
Biomedical Engineering
U19BMV31 – BIOMECHANICS
(Regulation 2019)

Time: Three Hours | Maximum: 100 Marks

Answer ALL the questions

Knowledge Levels (KL)	K1 – Remembering	K3 – Applying	K5 - Evaluating
	K2 – Understanding	K4 – Analyzing	K6 - Creating

PART – A

(10 x 2 = 20 Marks)

Q.No.	Questions	Marks	KL	CO
1.	State the conditions required for a body to be in equilibrium under coplanar forces.	2	K2	CO1
2.	Give one example to illustrate Newton's first law.	2	K2	CO1
3.	List the factors that affect the rheology of blood.	2	K2	CO2
4.	Distinguish between laminar and turbulent flow.	2	K2	CO2
5.	Give one example of a biological tissue showing viscoelastic behavior and justify your answer.	2	K2	CO3
6.	Why is bone considered anisotropic?	2	K2	CO3
7.	Define Joint reaction force.	2	K2	CO4
8.	What are the major stresses experienced by the knee joint?	2	K2	CO4
9.	State two ergonomic principles for good workplace design.	2	K2	CO5
10.	Identify the importance of posture analysis in ergonomics.	2	K2	CO5

PART – B

(5 x 13 = 65 Marks)

Q.No.		Questions	Marks	KL	CO
11.	a)	A person holds a 5 kg load in the hand with the forearm horizontal. The forearm is 30 cm long, and the biceps tendon is attached 4 cm from the elbow joint. (*Apply Newton's laws and moment equilibrium equations)* Draw a free-body diagram showing all forces acting on the forearm. Calculate the biceps muscle force required to keep the arm in equilibrium. Discuss the mechanical advantage or disadvantage of such muscle arrangement in the human body.	13	K2	CO1
		(OR)			
	b)	Compare and contrast the viscoelastic, viscous, and inviscid behavior of biological materials. Discuss their constitutive equations, typical stress–strain or stress–rate relationships, and one example for each. Highlight the importance of these behaviors in accurate biomechanical simulations and device design.	13	K2	CO1
12.	a)	Differentiate between native heart valves and prosthetic heart valves based on structure, function, and flow characteristics. Explain how valve geometry affects the pressure drop and flow turbulence across the valve.	13	K3	CO2
		(OR)			
	b)	Illustrate and explain the velocity distribution of blood flow in a straight cylindrical tube. Discuss the assumptions made in deriving this model and explain the physiological significance of the velocity profile.	13	K3	CO2
13.	a)	A cortical bone with a rectangular cross-section of 20 mm × 10 mm is subjected to a bending moment of 50 N·m. Draw the bending stress distribution across the cross-section, calculate the maximum tensile and compressive stresses, assess the likelihood of a transverse fracture, and suggest an appropriate type of implant for stabilization	13	K3	CO3
		(OR)			
	b)	Explain the kinematics and kinetics of the elbow joint during flexion–extension. Include a discussion on degrees of freedom, angular velocity, angular acceleration, and moment generation by muscles.	13	K3	CO3
14.	a)	A person lifts a 10 kg weight with the arm abducted to 90° at the shoulder. The humerus length is 0.3 m, and the deltoid muscle has a moment arm of 0.05 m at the glenohumeral joint. Draw a free-body diagram (FBD) of the humerus showing all forces acting on it. Calculate the force generated by the deltoid muscle required to hold the weight in this position.	13	K3	CO4

(OR)

Q.No.		Questions	Marks	KL	CO
	b)	Discuss the influence of walking speed on gait parameters such as step length, cadence, joint angles, and ground reaction forces. Explain the biomechanical implications for rehabilitation and prosthetic design.	13	K3	CO4
15.	a)	A lumbar spine segment is modeled with vertebrae and intervertebral disc. Under a compressive load of 1000 N: Explain the steps to perform finite element analysis of the lumbar spine.Identify key material properties for vertebrae, disc, and ligaments. Predict which areas are at highest stress and explain why.Suggest how FEA results can guide implant design or surgical planning.	13	K3	CO5
		(OR)			
	b)	Consider a computer workstation for a 5'8" user working 8 hours/day: Explain ergonomic principles applied for chair, desk, keyboard, and monitor.Sketch the ideal neutral posture at the workstation.Identify risk factors for musculoskeletal disorders and propose mitigation and explain how repetition and force minimization reduces injury risk.	13	K3	CO5

PART – C

(1 x 15 = 15 Marks)

Q.No.		Questions	Marks	KL	CO
16.	a)	"Biological tissues rarely behave as purely elastic or viscous systems. Instead, they exhibit viscoelastic behavior characterized by time-dependent stress and strain."		K3	CO3
		i. Explain this statement with reference to Maxwell and Voigt models.Derive their constitutive equations.Compare their stress relaxation and creep responses with neat sketches.	10		
		ii. Discuss the practical importance of viscoelastic modeling in biomedical implant design and tissue engineering.	5		
		(OR)			
	b)	You are designing a low-cost gait analysis setup for a physiotherapy clinic.		K3	CO5
		i. Identify the essential sensors and equipment and explain the biomechanical parameters measurable with your system.	8		
		ii. Describe how data would be processed to derive spatiotemporal, kinematic, and kinetic information and discuss how such data can improve patient rehabilitation outcomes.	7		