

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-VI (NEW) EXAMINATION – WINTER 2024

Subject Code:3160308

Date:02-12-2024

Subject Name:Biomechanics

Time:02:30 PM TO 05:00 PM

Total Marks:70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

- Q.1**
- (a) Define the terms joint and articulation in the context of biomechanics. **03**
- (b) Describe the biomechanical factors that influence the stability of standing posture. **04**
- (c) Draw and explain the stages of normal GAIT movement. **07**
- Q.2**
- (a) State Newton's three laws of motion and provide a brief explanation for each. **03**
- (b) Determine the resultant force of two concurrent forces, $F_1 = 10\text{ N}$ and $F_2 = 15\text{ N}$, acting at an angle of 60 degrees. **04**
- (c) Consider the arm shown in below given Figure (a). The elbow is flexed to a right angle and an object is held in the hand. The forces acting on the forearm are shown in Figure (b). Assume that the biceps as the major flexor and that the line of action of the tension (line of pull) in the biceps as vertical. Draw the free-body diagram and determine the magnitudes of the muscle tension and the joint reaction force at the elbow given below parametric values.
1. distances between point O and points A = 4 cm
 2. distances between point O and points B = 15 cm
 3. distances between point O and points C = 35 cm
 4. weight of the object held in the hand = 80 N
 5. total weight of the forearm = 20 N

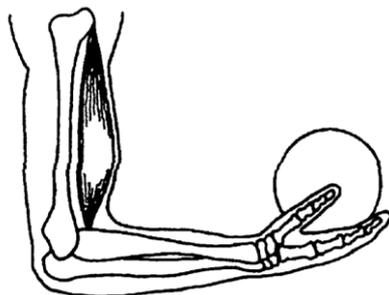


Figure (a)

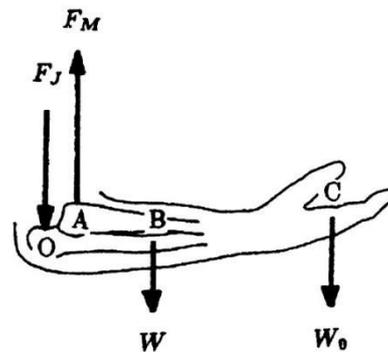


Figure (b)

OR

- (c) A 5-kg block is released from rest at the top of a 10-meter-high ramp. The ramp is inclined at an angle of 30 degrees to the horizontal. Determine the speed of the block at the bottom of the ramp, neglecting friction. **07**
- Q.3**
- (a) Enlist various intrinsic fluid properties. **03**

- (b) Blood flows through an artery with a diameter of 2 mm at a velocity of $0.5 \frac{m}{s}$. The density of blood is $1050 \frac{kg}{m^3}$, and its viscosity is 0.004 Pa·s. Calculate the Reynolds number and determine if the flow is laminar or turbulent. **04**
- (c) Explain the concept of biotribology and its importance in the design of orthopedic implants. **07**

OR

- Q.3** (a) Define the terms force and moment. Explain their significance in mechanics. **03**
- (b) Analyze the mechanical properties of cartilage and its role in joint lubrication and load-bearing. **04**
- (c) Explain the Hill's muscle model and its components. Analyze the force-velocity relationship of a muscle. **07**
- Q.4** (a) Enlist primary types of artificial heart valves. **03**
- (b) Explain the concept of moment of inertia and its significance in rotational motion. **04**
- (c) Discuss the hemodynamic effects of hypertension on the cardiovascular system. **07**

OR

- Q.4** (a) Define the term viscoelasticity and list various viscoelastic properties of hard tissue. **03**
- (b) Discuss the biomechanical principles involved in gait analysis for individuals with disabilities. **04**
- (c) Discuss the mechanical properties of tendon tissue and its role in transmitting force between muscle and bone. **07**
- Q.5** (a) Draw and explain the variation of the viscosity of human blood with shear rate and temperature. **03**
- (b) Analyze the fluid flow through a blood vessel using the Bernoulli equation. **04**
- (c) A person is standing on one leg. Draw a free body diagram and equate the forces acting on the hip joint, assuming the leg is a rigid body. **07**

OR

- Q.5** (a) Enlist different types of biomaterials used in orthopedic implants and their properties. **03**
- (b) Explain the mechanical properties of bone tissue, including its strength, stiffness, and ductility. **04**
- (c) Discuss the factors that influence the design and selection of an artificial heart valve. **07**
