

Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 6 – EXAMINATION – SUMMER 2026

Subject Code: 3160308

Date: 29/05/2026

Subject Name: Biomechanics

Time: 10:30 AM TO 01:00 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.**

- Q.1**
- (a) State and explain Newton's three laws of motion with suitable examples. **03**
 - (b) Explain the Kelvin-Voigt model of soft tissue and its viscoelastic behavior. **04**
 - (c) Analyze the forces acting on the hip joint during one-leg stance with suitable assumptions. **07**
- Q.2**
- (a) Draw a free body diagram (FBD) of the elbow joint and describe the forces acting on it. **03**
 - (b) Derive Hagen-Poiseuille equation and explain its biomedical application in blood flow analysis. **04**
 - (c) Describe Hill's muscle model and explain the force-velocity relationship of muscles. **07**
- OR**
- Q.2**
- (c) Explain fixation methods used for orthopedic implants with examples. **07**
- Q.3**
- (a) Differentiate between tendons and ligaments with respect to their structure and function. **03**
 - (b) Compare different types of joints in human body with examples of upper and lower limbs. **04**
 - (c) Describe the manufacturing process and testing of artificial heart valves. **07**
- OR**
- Q.3**
- (a) List and explain the mechanical properties of cortical and cancellous bone. **03**
 - (b) Apply Bernoulli's equation to determine pressure drop in arteries with a given example. **04**
 - (c) Discuss rheological properties of blood and explain its non-Newtonian nature. **07**
- Q.4**
- (a) Explain Couette flow and its application in biological systems. **03**
 - (b) Explain the concept of moment of inertia and its significance in biomechanics. **04**
 - (c) Compare laminar and turbulent flow in the context of human circulatory system. **07**
- OR**
- Q.4**
- (a) Explain the design considerations of orthopedic implants with respect to biocompatibility. **03**
 - (b) Discuss the GAIT cycle and identify key biomechanical parameters measured during gait analysis. **04**

(c) Discuss material modeling approaches for cartilage and its load-bearing characteristics. 07

Q.5 (a) Explain the importance of material selection for prosthetic joints and implants. 03

(b) Describe biomechanics of sitting posture and factors affecting spinal load distribution. 04

(c) A rigid body in a plane is acted upon by two coplanar forces: $F_1=50\text{ N}$ at 30° from the $+x$ axis applied at point $A(1,1)\text{ m}$, and $F_2=80\text{ N}$ at -45° from the $+x$ axis applied at point $B(4,2)\text{ m}$. Determine the resultant force $R=F_1+F_2$, its magnitude and direction, the resultant moment about the origin $M_O=r_A\times F_1 + r_B\times F_2$, the perpendicular distance $d=|M_O|/|R|$ from the origin to R 's line of action, and sketch a diagram showing points A, B, the forces, resultant, line of action, and distance d . 07

OR

Q.5 (a) Define viscosity and explain how it affects blood flow in vessels. 03

(b) Explain anisotropic behavior of bone and its engineering significance. 04

(c) Explain the biomechanics of knee joint with a neat diagram showing forces acting during flexion. 07
