

### MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

### I SEM M.Tech (BME) DEGREE END-SEMESTER EXAMINATIONS, NOV/DEC 2023

# SUBJECT: BIOMATERIALS AND BIOMECHANICS (BME 5114) (REVISED CREDIT SYSTEM)

Tuesday, 05<sup>th</sup> December 2023, 9:30 AM to 12:30 PM

#### TIME: 3 HOURS

## MAX. MARKS: 50

#### **Instructions to Candidates:**

1. Answer ALL questions.

2. Draw labeled diagram wherever necessary.

3. Use separate answer book for PART-A and PART-B.

#### PART-A: BIOMATERIALS (Use separate answer book)

1A Identify the polymerization steps involved in the following polymer
 (a) -O-C(H2)-O-C(H3)-O-C(H2)-O (b) -C(F2)-C(F2)-C(F2)-C(F2)-

2

- 1B Sonam was asked to design a composite material from carbon fiber and resin for 4 fracture plate. The values of the modulus of carbon fiber and resin are 200 GPa and 20 GPa respectively. What volume of carbon fiber will be required to make the modulus of the composite plate 100 GPa? Assume that the fibers are aligned in the direction of the test and V<sub>resin</sub> + V<sub>fibers</sub> =1.
- 1C A sample of monomer (-CH<sub>2</sub>-CH-CH<sub>3</sub>) is polymerized. The polymer has degree of 4 polymerization (DP) 1. Calculate the molecular weight of the polymer. Can the said polymer exhibit different values of Young's moduli? Justify.
- 2A Explain the effects of the following factors on the mechanical strength of a 4 polymer.
  - (i) Molecular weight, (ii) side chain substitution, (iii) crosslinking and (iv) glass transition temperature.
- 2B Differentiate coated and uncoated hip joint implant fixation. Compare total hip 3 replacement and hemi hip replacement.
- 2C The bone density values of three patients who are willing to have dental implants 3 are provided.
  - P1: Bone density: 900 HU,
  - P2: Bone density: 850, Sinus dips down, bone height <8mm.
  - P3: Bone density: 300 HU

Analyze and indicate your suggestion of dental implants for the patients.

		Reg. No.											
3A	Discuss the steps involved in the fixation of dental implant. Compare endosteal 3 and subperiosteal dental implants.												
3B	Analyze the impact of 'central blood flow' on the stability of mechanical heart z valve.											2	
PART-B: BIOMECHANICS (Use separate answer book)													
4 A	Describe the temporal and spatial parameters of the gait cycle.											3	
4 B	<ul> <li>A shotput leaves the thrower's hand at 15 m/s at angle of 42° and a height of 1.3m.</li> <li>What will be the shot's flight time?</li> <li>What will be the shot's maximum height?</li> <li>How far will the shot travel from the thrower's hand before it lands?</li> </ul>											2	
5 A	Analyze in depth the common injuries during activity of the elbow and the wrist.										3		
5 B	Employ the PNF method for Hamstrings muscle?									2			

- 6 A Analyze the forces acting on the temporomandibular joints during activity. Highlight the 3 causes, signs, symptoms and the factors that may increase the disorder.
- 6 B Consider the following free body diagram shown in Fig 6 B. Using static analysis, solve 2 for the moment at the elbow if d1 is 0.039 m, d2 is 0.142 m, and d3 is 0.450 m. What is the net muscle force?



Fig 6 B

7 A How much force must be produced by the brachioradialis and biceps F<sub>m</sub> to maintain the 3 15 N forearm and hand in the position shown in Fig 7 A. The moment arm for the muscles is 5 cm and 15 cm for the forearm/ hand weight. What is the magnitude of joint reaction force?



Fig 7 A

- 7 B A runner weighing 62 kg is running forward at 8 m/s when his foot strikes the ground. 2 The vertical ground reaction force acting under his foot at this instant is 1800 N. The friction force acting under his foot is a 350 N braking force. These are the only external forces acting on the runner other than the gravitational force. What is the runner's vertical acceleration, as a result of these forces?
- 8 A With respect to the free body diagram of the arm and the shoulder shown in Fig 8 A, the weight of the arm is 38 N. The moment arm for the total arm segment is 34 cm and the moment arm for the deltoid muscle F<sub>m</sub> is 3.5 cm. How much force must be supplied by the deltoid to maintain the arm in this position? What is the magnitude of the horizontal component of the joint reaction force R<sub>h</sub>?



Fig 8 A

8 B With appropriate sketches and mathematical expressions explain the different types of 2 levers.