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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, Nov/Dec 2023

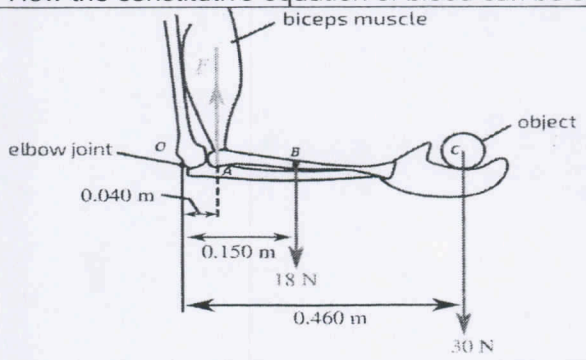
Biomedical Engineering
7th Semester
BM5701 BIOMECHANICS
(Regulation2019)

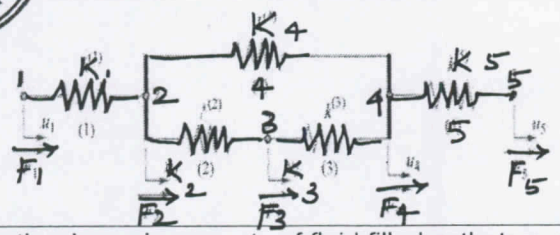
Time:3hrs Max.Marks: 100

CO1	Understand the use of mechanics in medicine.
CO2	Understand the mechanics of physiological systems.
CO3	Distinguish the reason for abnormal patterns
CO4	Analyze the biomechanical systems using mathematical models.
CO5	Design and develop the models specific to orthopedic applications.

BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

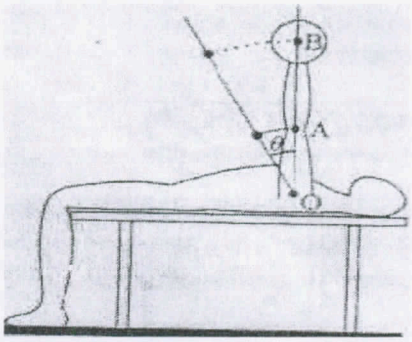
PART- A(10x2=20Marks)
(Answer all Questions)

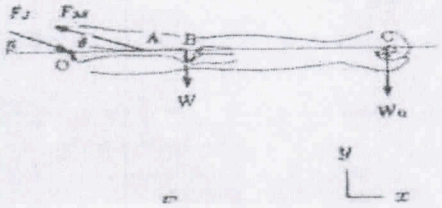
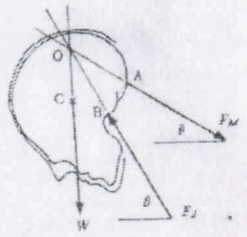
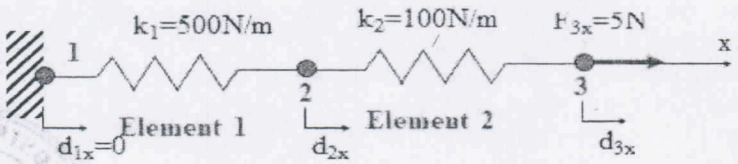
Q.No	Questions	Marks	CO	BL
1	A metal guided wire is 3mm diameter ans 5m long. When a force of 15N is applied during a surgery it stretched by 0.3mm. Calculate the elastic modulus.	2	1	3
2	A titanium implant of diameter 4mm and length 24mm is placed inside, which is subjected to a tensile force of 200N. Estimate the change in length it undergoes for E=100GPa.	2	1	3
3	A small artery has a length of 1.1mm and a radius of 0.25μm. If the pressure drop across the artery is 1.8KPa, what is the flow rate through the artery. Assume the viscosity of the fluid is 3Pa.Sec	2	2	3
4	How the constitutive equation of blood can be specified?	2	2	2
5	 Figure 1 For the figure 1 compute the moment acting at the elbow joint and the muscular force F.	2	3	3
6	How joints are classified based on its function?	2	3	2
7	Compute the global stiffness matrix of the assemblage of spring shown in Figure2	2	4	3

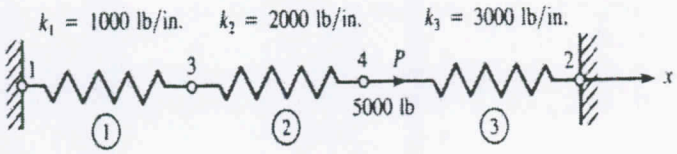
	 Figure 2			
8	Why the dynamic property of fluid filled catheters should be analyzed?	2	4	1
9	Give the effects of mechanical vibration	2	5	1
10	Enumerate the need for gait analysis.	2	5	1

PART- B(5x 13=65Marks)

(Restrict to a maximum of 2 subdivisions)

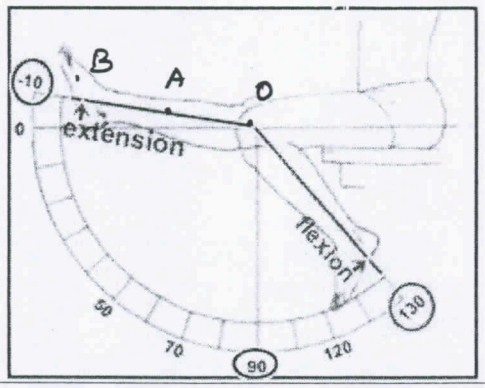
Q.No	Questions	Marks	CO	BL
11 (a) (i)	Consider an athlete is strengthening his shoulder joint by lowering and raising a bar bell with arms straight while lying down as shown in Figure 3 The weight of the bar bell is W_b at a distance 'B' from the shoulder joint (point O) and W_a is weight of the arms acting at a distance 'A' from the shoulder joint. For a given values of OA = 40 cm, OB = 70 cm, W_a = 300 N and W_b = 500 N. Draw the free body diagram and find the moment at the shoulder joint with following conditions (i). θ = 0 (arm is horizontal) (ii). θ = 90 (arm is vertical). (iii) θ = 60, (iv) θ = 30, (v) θ = 15, (vi) θ = 45  Figure 3	6	1	3
(ii)	Discuss the mechanics of bone and illustrate its mechanical properties	7	1	3
	OR			
11 (b) (i)	A high strength steel rod with E=200GPa and the poisons ratio of 0.32 with a diameter of 5cm is being subjected to a compressive load of 10KN. Determine the increase in diameter of the tube after the load is applied.	5	1	3
(ii)	Describe the concept of blood Rheology with necessary equations.	8	1	3
12 (a) (i)	A capillary tube is 30mm long and 1mm in diameter. It produces a flow rate of 8mm^3/s, where the fluid density is 800kg/m^3. Calculate the dynamic and kinematic viscosity of the fluid if the Reynolds number is 200	5	2	3
(ii)	Prove the velocity profile of blood is parabola.	8	2	3
	OR			
12 (b) (i)	Distinguish the mechanical property of biological heart valves with neat diagram and explain how power developed by the heart will be calculated.	8	2	3

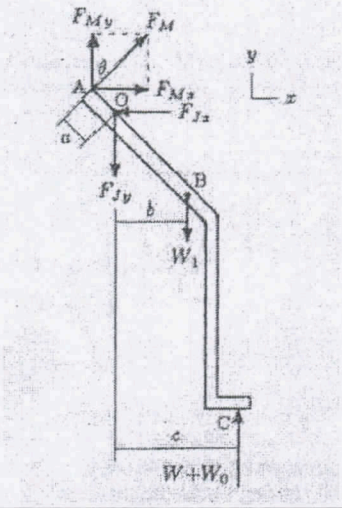
(ii)	The blood flow in a blood vessel of length 20cm and diameter of 25mm. the flow rate is 4.5cm^3/s and the dynamic viscosity is 3.5x10^{-3} Pa.s. Calculate the velocity and type of flow.	**5**	2	3
13 (a) (i)	Consider a person, strengthening the shoulder muscles by means of dumbbell exercises as shown in Figure 4. O corresponds to the axis of the shoulder joint. A is where the deltoid muscle is attached to the humerus, B is the center of gravity of the entire arm, and C is the center of gravity of the dumbbell. FM is the muscular force that makes an angle θ = 15^{0}and FJ is the joint reaction. Let OA=15cm, OB = 30cm, OC = 60cm. W= 40N and W0= 60N. Determine FM, FJ & β. And draw the free body diagram.  **Figure 4**	**7**	3	3
(ii)	Discuss the diffusion property of articular cartilage and Compare its property with the synovial fluid.	**6**	3	3
	OR			
13 (b) (i)	A scientist whose head weighs W=7Kg is looking into a microscope as shown in Figure 5. Its centre of gravity is located at C. F_M is the magnitude of the neck extensor muscle which is applied on the skull at A. The atlanto occipital joint center is located at B and F_J is the joint reaction force that's makes an angle β=30^0. For the flexed position of the head the line of action of the neck muscle makes an angle θ=35^0. Estimate F_M and F_J. Draw the free body diagram  **Figure 5**	**6**	3	3
(ii)	Explain the different types of synovial joint and the property of synovial flyuid.	**7**	3	3
14 (a) (i)	What is pulse wave velocity? Derive its necessary equation	**9**	4	2
(ii)	Consider the two element system as given in Figure 6. The node 1 is attached to the fixed support, yielding the displacement constraint d1=0 and F2=0 for these conditions compute d2, d3 and F1. **Figure 6**  	**4**	4	2

	OR			
14 (b) (i)	What is Finite element methods? Discuss its application in Medical field with suitable examples.	**7**	4	2
(ii)	Consider the 3 spring system shown in Figure 7, the boundary conditions at node1 and node 2 are U1=U2=0, obtain the global matrix and compute F1and F2, where F3=0  **Figure 7**	**6**	4	2
15 (a)	Discuss the mechanics of Knee for walking.	**13**	5	2
	OR			
15 (b) (i)	How gait analysis will be performed? Explain.	**7**	5	2
(ii)	Discuss about the protective methods against vibration.	**6**	5	2

PART- C(1x 15=15Marks)

(Q.No.16 is compulsory)

Q.No	Questions	Marks	CO	BL
16. (i)	As illustrated in Figure 8 consider an athlete wearing a weight boot, and from sitting position doing lower leg flexion/ extension exercises to strength quadriceps muscles. The weight of the athlete lower leg W1=50N and the Weight of the boot is w2=100N. As Measured from the knee joint at O, the centre for gravity of the lower leg is located at a distance OA= 20cm and the center of gravity of the weight boot is located at Where OB= 50cm. Determine the net moment generated about the knee joint when the lower leg extended horizontally and when the lower leg makes an angle 30°, 45°,60°,75°,90° with the horizontal.  **Figure 8**	**7**	1	6
(ii)	Consider the weight lifter who is bent forward and lifting a weight W0=100Kg.The free body diagram is shown in Figure 9. Where W =95Kg is the total weight of the athlete, W1= 0.5W is the weight of the legs, including the pelvis, W+W0 is the total ground reaction force applied to the athlete through the feet at the point C.FM is the muscular force and FJ is the joint reaction force, generate at the union O of the sacrum and the fifth lumbar vertebra. The centre of gravity of the leg including the pelvis is	**8**	3	6

	located at B. Relative to O, the lengths of the lever arms of the muscle force, lower body weight , and ground reaction force are measured as a= 0.5cm, b= 1.8cm and c = 3cm respectively . Assume that at an instant the athlete is bent so that his trunk makes an angle θ = 45º . Determine FM & FJ.  **Figure 9**			