



VIT

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

REG.NO.: 24BNT0014

SCHOOL OF HEALTHCARE SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2025-2026

SLOT: E1 + TE1

Programme Name & Branch : B. Tech Healthcare Science and Technology
Course Code : BHST203L
Course Name : Fundamental Principles of Biomechanics
Faculty Name(s) : Dr. Mohan Varma D. S.
Class Number(s) : VL2025260100966
Date of Examination : 21st August 2025, Session 1 – 09:30 to 11:00am
Exam Duration : 90 minutes Maximum Marks: 50

General instruction(s):

Make suitable assumptions if required.

10 x 5 = 50 Marks

1. A person is holding an object of weight $W_o = 60$ N in his hand with his elbow flexed and making an angle θ with the positive x-axis as shown in Fig. 1. Point O is the axis of rotation of the elbow joint, point A is the point of attachment of the biceps muscle, point B is the centre of gravity of the forearm and point C is centre of gravity of the object held. If the $OA = 5$ cm, $OB = 20$ cm, and $OC = 40$ cm and the weight of the forearm $W = 70$ N. Determine the magnitude of the muscle force F_m and the x and y components of the reaction force at the elbow joint when (a) $\theta = 10^\circ$, and $\Phi = 10^\circ$ (b) $\theta = 0^\circ$ and $\Phi = 0^\circ$ and (c) $\theta = -10^\circ$ and $\Phi = 10^\circ$. Make suitable assumptions. (Note: figures are not to scale).

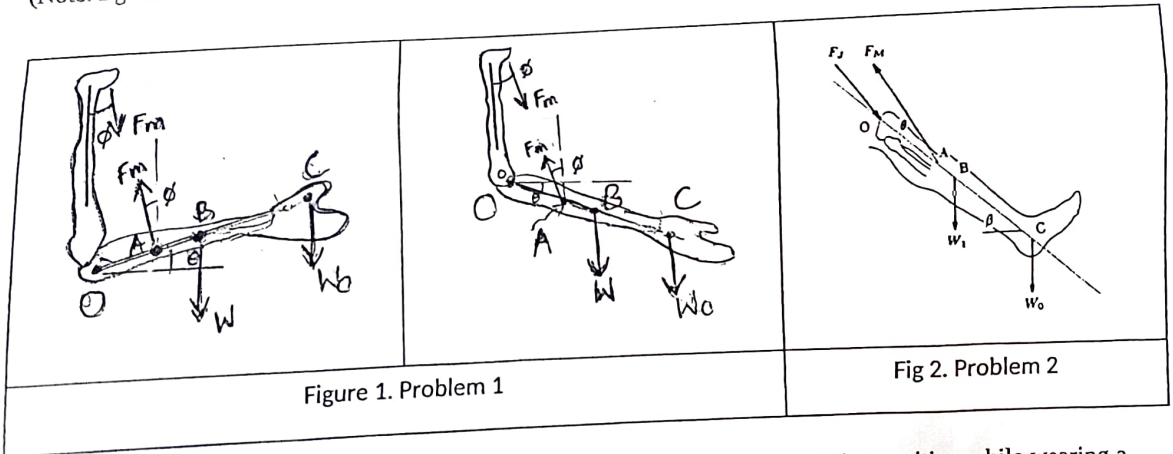


Figure 1. Problem 1

Fig 2. Problem 2

2. Consider a person performing lower leg flexion-extension exercises from a sitting position while wearing a boot weighing $W_o = 132$ N. Forces acting on the leg are shown in Fig. 2. Point O designates the center of rotation of the tibiofemoral joint. A is the point of attachment of the patellar tendon to the tibia, point B is the center of gravity of the lower leg, and point C is the center of gravity of the weight boot. For this system assume that the points O, A, B, and C all lie along a straight line. The distances $OA = 13$ cm, $OB = 23$ cm, and $OC = 53$ cm, respectively measured along the line OC. For this position of the leg, the long axis of the tibia makes an angle $\beta = 45^\circ$ with the horizontal, and the line of action of the quadriceps muscle force makes an angle $\theta = 15^\circ$ with the long axis of the tibia. If the weight of the lower leg is $W_1 = 163$ N. Determine the magnitude of the quadriceps muscle force and the reaction force at the tibiofemoral joint.

3. Consider a person working by holding his head bent forward as shown in Fig. 3, requiring neck extensor muscles to support the head. Given the line of action of the vertebral force F_v exerted at the atlantooccipital joint

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and the line of action of the neck extensor muscles F_m , determine the magnitudes of these forces as a fraction of the weight of the head W . As is shown in the figure, Force F_v makes 65° with the horizontal and the force F_m makes 35° with the horizontal.

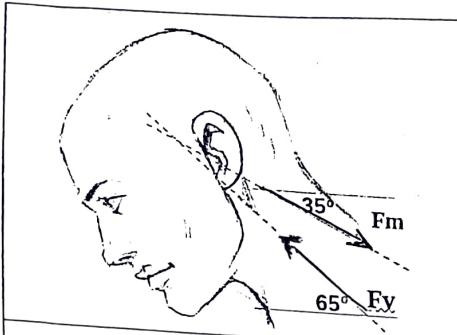


Fig. 3. Problem 3

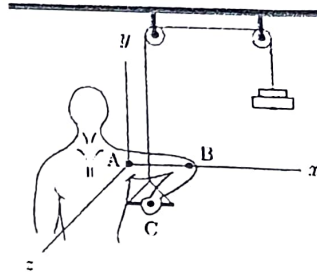


Fig. 4 Problem 4

4. Figure 4 illustrates a person using an exercise machine. Points A and B correspond to the shoulder and elbow joints, respectively. Relative to the person, the upper arm (AB) is extended toward the left (x direction) and the lower arm (BC) is extended forward (z direction). At this instant the person is holding a handle that is connected by a cable to a suspending weight. The weight applies an upward (in the y direction) force with magnitude F on the arm at point C. The lengths of the upper arm and lower arm $a = 35$ cm and $b = 40$ cm, respectively, and the magnitude of the applied force $F = 400$ N. Determine the force generated at the elbow and the shoulder joint due to the applied force. Also determine the moments generated about the shoulder and elbow joint due to the applied force F .

5. Calculate the moment of inertia of the thigh about its COM, its distal end, and its proximal end. Mass of the person is 80 kgs. The thigh length is given as 0.410 m. Anthropometric data table is given below.

Segment	Segment wt / Body wt	Centre of Mass / Segment Length		Radius of Gyration / Segment Length
		Proximal	Distal	
				about C of G
Foot	0.0145	0.5	0.5	0.475
Leg	0.0465	0.433	0.567	0.302
Thigh	0.10	0.433	0.567	0.323

END