REG.NO.:

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

SCHOOL OF HEALTHCARE SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST -II
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	:9th Oct. 2025, Session 2 – 02:00pm to 3:30pm
Exam Duration	: 90 minutes Maximum Marks: 50

General instruction(s): Make suitable assumptions if required.

5 x 10 = 50 Marks

1) Determine the x and y components of the reaction force exerted on the hands for the given instance during push-ups for a person of mass 70 kg. At the given instance, the angle made by the forearm with positive x-axis is $\theta = 120°$ (Figure 1). Angular velocity of the forearm $\dot{\theta} = 2.5$ rad/sec counter clockwise. Angular acceleration of the forearm $\ddot{\theta} = 0$ rad/sec^2. Make the following assumptions: (i) The forearm and the upperarm are roughly equal in length = 25 cm. (ii) The mass of the arms is negligible when compared to the rest of the body (i.e., assume the arms to be massless). (iii) Assume that the whole body weight acting at the center of mass can be replaced by a point mass (which is 0.7 times the body weight) acting vertically downwards at the shoulder, and (iv) The shoulder is vertically above the hands.

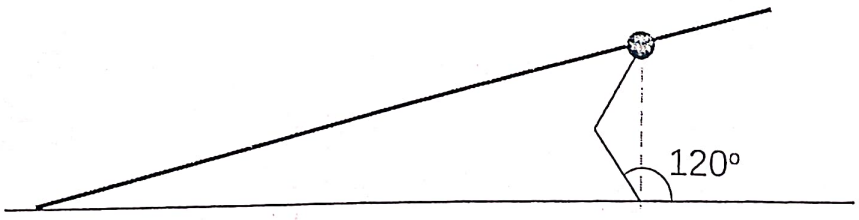

Figure 1

2) Marker data is collected in a gait lab for a person walking at a self-selected speed. The (x,y) co-ordinates of the ankle and metatarsal markers for a randomly chosen instance during swing phase of the limb are: ankle$(0.75\hat{i} + 0.15\hat{j})$m and metatarsal$(0.83\hat{i} + 0.06\hat{j})$m. The velocity of the ankle is $(3.9\hat{i} - 0.79\hat{j})$ m/sec. The acceleration of the ankle is $(1.3\hat{i} + 8.6\hat{j})$ m/sec^2 The angular velocity of the foot at this instance is $(6.85\,\hat{k})$ rad/sec and the angular acceleration of the foot at this instance is $(-10\,\hat{k})$ rad/sec^2. Find the position (x,y), velocity and acceleration of the center of mass of the foot segment. Anthropometric data for the foot is as follows: foot segment length = distance between ankle marker and metatarsal marker; distance of center of mass = 0.5 x segment length (from proximal joint).

3) Given that the mass of the person is m = 56.7 kg, determine the joint reaction force and the net muscle moment acting at the ankle joint for the person at the instance given in Problem 2. Anthropo-metric data is as follows - mass of foot segment = 0.0145 x total mass; radius of gyration = 0.475 x segment length (for Moment of Inertia about the center of mass).

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4) A bone scaffold sample made of material (Young's modulus E = 200 GPa and ν = 0.35) is tested for it's strength. An axial tensile force of Fx = 5 MN along x-axis, axial compressive force of Fy = 5 MN along y-axis and an axial compressive force of Fz = 5 MN along z-axis is applied on the sample of dimensions 20 cm x 2 cm x 2 cm (Figure 2). Determine the average normal stresses and strains induced in the scaffold.

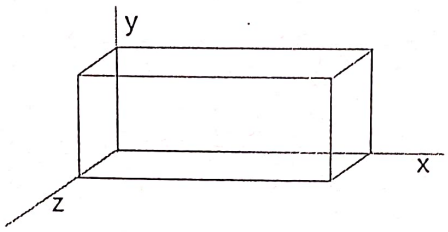

Figure 2

5) At a given material point of a sample, the stresses induced are 291 MPa tensile stress along x-axis. 9 MPa tensile stress along y-axis and shear stress of 51.32 MPa. Find the maximum principal stress and the inclination of the plane on which this stress occurs. Also, find the maximum shear stress at the given material point.