Ref. No.: Ex/FTBE/ES/H/T/317/2025

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING, 2025
(3rd Year, 1st Semester)

MECHANICS OF SOLID (HONS.)

Time: Three hours Full Marks: 100

Answer any *five* questions

1. a) For a vector with direction cosines l, m, n prove that $l^2 + m^2 + n^2 = 1$. (10)

   b) Two vectors are given as **A** = (6i + 10j + 16k) N and **B** = (2i - 3j) N. **C** is also a vector in the xy plane at an inclination of 30^0 to the positive x-axis and directed away from the origin. The magnitude of C is 50 N. Find the sum of vectors **A, B, C**. (10)

2. a) The force F is expressed as a function of position as $\mathbf{F} = (10x - 6)\mathbf{i} + (x^2z)\mathbf{j} + (xy)\mathbf{k}$. What are the direction cosines of the force at position (1, 2, 2)? What is the position along the x coordinate where $F_x = 0$? F_x is the scalar component of **F** along x-axis. (10)

   b) Given a force **F** = (20i + 10j + Pk) N. If this force is to have a component of magnitude 16 N along a line having a unit vector **r** = 0.6i + 0.8k , what should be the value of P?

   What is the angle between between **F** and **r** ? (10)

3. Write down the equations of equilibrium for a rigid body subjected to parallel and concurrent system of forces. Define statically determinate and statically indeterminate problems. A weight Q is suspended from point B of an inextensible cord ABC, the ends of which are pulled by equal weights P over-hanging small pulleys A and C which are on the same level (Figure Q3). Neglecting the radii of the pulleys determine the sag BD if AC = 4 m, P = 40 N and Q = 20 N. (20)

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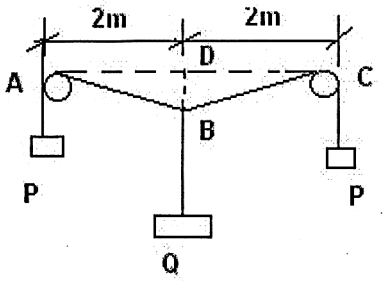

Figure Q3

4. a) What is the component of the cross product (**A x B**) along the direction n where

A = 10i + 16j + 3k, **B** = 5i – 2j + 2k, and **n** = 0.8i + 0.6k . (10)

b) A mild steel tensile test specimen, having a circular cross-section of diameter, d = 1.5 cm shows an elongation reading of 0.01 cm over a length of 10.0 cm. Calculate the tensile stress developed in the material, assuming Young's Modulus of Elasticity E = 0.8 x 10^6 kgf/cm^2. (10)

5. a) For torsion of a circular shaft with usual notations show that

$$\tau_{max}/R = \tau/r = (G\theta)/L \quad (10)$$

b) A steel shaft 10 mm in diameter turns at 12,000 rpm. What is the maximum power that such a shaft may develop if the assigned working stress in shear is 400 kgf/cm^2. (10)

6. a) Discuss about the stress strain behavior of Mild Steel showing its salient points. Distinguish between yield stress and proof stress. (10)

b) Draw the shear force and bending moment diagrams of a simply supported beam subjected to uniformly distributed load. (10)