BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2022-23
ME F312: Adv Mechanics of Solids
Comprehensive Exam (OPEN BOOK)

Max Marks: 40 Duration: 3 Hours Date: December 23, 2022

Q1. Show that if all the components of stress (i.e. σ_x, σ_y, σ_z, τ_{xy}, τ_{yz}, τ_{xy}) are equal to one other, the state of stress is uniaxial. Also define the plane. **[3]**

Q2. A steel tube 2.5 m long has the cross-section shown in **FigQ2**. The tube is transmitting a torque of 200 N-m. Determine the average shear stress (in **MPa**) in each wall and the angle of twist (in **degree**) of the tube. Take t_1 = 3 mm, t_2 = 4.5 mm, t_3 = 7.5 mm, a = 30 mm, b = 60 mm, c = 75 mm, E = 205 GPa and υ = 0.3 **[12]**

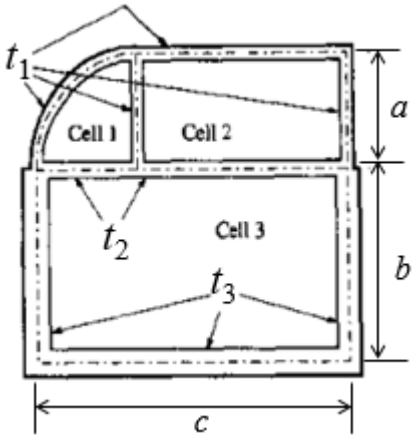


Fig Q2

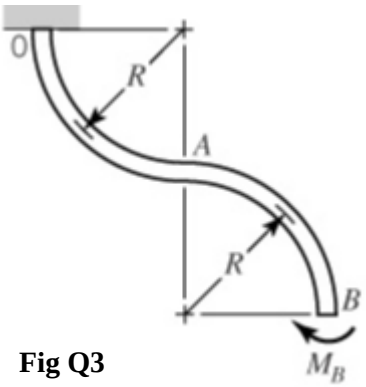


Fig Q3

Q3. Member *OAB* in **FigQ3** lies in one plane and has the shape of two quadrants of a circle. Determine **(a)** the horizontal and vertical component of the deflection of point *B* terms of loading, modulus of elasticity *E*, radius of curvature *R*, cross-section area *A*, and moment of inertia of the cross section *I*. **(b)** the change in slope of the cross section at point *B* for the member. **[10]**

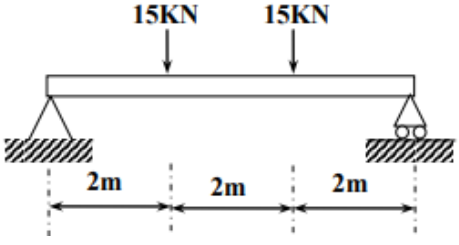
Q4. The displacement field of a beam under an unknown load is assumed to be **[5]**

$u = -0.2xy$ $v = 0.1(x^2 + 0.3y^2 - 0.3z^2)$ $w = 0.03yz$

Consider a line element located at (0.1, 0.05, 2) with an initial direction along $1\hat{i} + 3\hat{j} + 5\hat{k}$.

(a) What is the engineering strain of the line element? **(b)** What is the new direction of the line element? Express the direction in terms of the direction cosines.

Q5. An angle beam of $300\,mm \times 300\,mm \times 30\,mm$ is loaded as shown in **Fig Q5**. Determine **[10]**
(a) Magnitude of maximum bending moment **(b)** Moment of inertia I_{xx}, I_{yy} and product of inertia I_{xy} **(c)** Orientation of neutral axis **(d)** Location and magnitude of maximum compressive and tensile stress



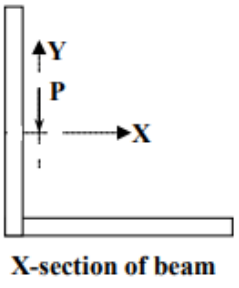


Fig Q5