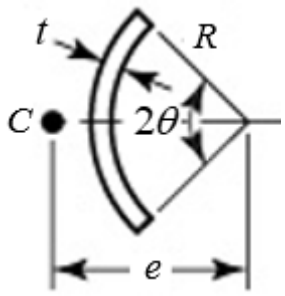
BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
ME G641: THEORY OF ELASTICITY & PLASTICITY
FIRST SEMESTER 2023-24
Comprehensive Examination: **PART-A (CLOSED BOOK) (2PM to 5 PM)**
Max Marks: 30 Duration: 60 minutes December 11, 2023

1. The exam is divided into Part-A (Closed-book type) and Part-B (Open-book type).
2. Part-A and Part-B are to be answered in separate answer sheets.
3. You have 1 Hour to answer Part-A. Early and late submission of Part-A is allowed.

Q1. Consider a closed cylinder of inner radius (r_i = ***a***) and outer radius (r_o = ***b***) subjected to internal pressure $\boldsymbol{p_1}$ only. Obtain the octahedral shear stress ($\boldsymbol{\tau_{oct}}$) at the inner radius as a function of the internal pressure $\boldsymbol{p_1}$, radii ***a*** and ***b***. Determine the octahedral shear stress magnitude if $b = 2a$ and pressure $\boldsymbol{p_1}$ = 150 MPa, **[6M]**

Q2. Locate the shear center for the circular arc section with angle 2θ. Obtain the distance (e) from the center of arc as a function of θ and R. **[6M]**



Q3. Determine the *Shape factor* of *T*-section beam of dimensions $60\,mm \times 90\,mm \times 10\,mm$ as shown in **FigQ3**. **[8M]**

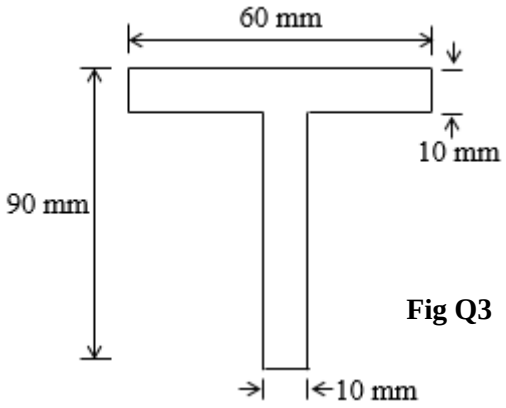


Fig Q3

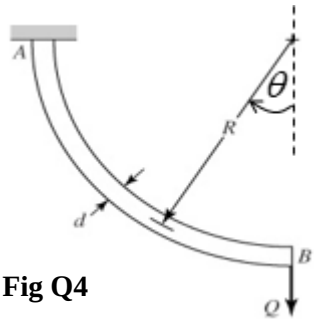


Fig Q4

Q4. The circular curved beam *AB* in **FigQ4** has a radius of curvature *R* and circular cross-section of diameter *d*. Determine (in terms of *E*, *R*, *I* and *Q*), (**a**) the horizontal and vertical displacement of point *B* (**b**) the rotation of the section at *B*. **[10M]**

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ME G641: THEORY OF ELASTICITY & PLASTICITY
FIRST SEMESTER 2023-24 Comprehensive Examination: **Part-B (OPEN BOOK)**
December 11, 2023 Max. Marks: 50 Duration: 2 Hours

Q1. The aluminum (G = 27 GPa) hollow thin wall torsion member has the dimensions shown in **FigQ1**. Its length is 4.5 m. If the member is subjected to a torque T = 15 kN-m, determine the maximum shear stress (in ***MPa***) and angle of twist (in ***degree***). **[10M]**

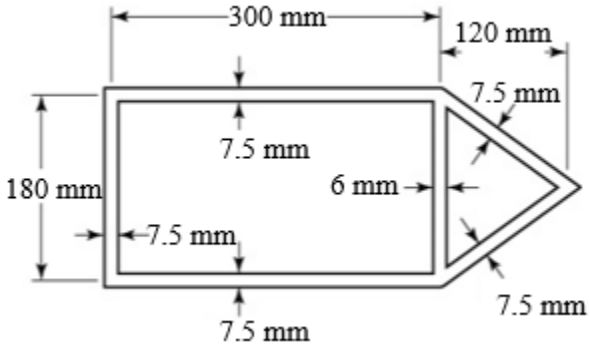

Fig Q1

Q2. The cantilever beam shown in **FigQ2**, is loaded with a linearly varying pressure with maximum magnitude **2*p*** at its free end. **(a)** Determine the suitable Airy's stress function for the stress field developed under the loading shown in **FigQ2**. Consider superposition up to 3rd order polynomial function (i.e. $\phi_2 + \phi_3$) as trial Airy's function for the problem.

(b) Find the generated strains and displacement components (u_x, u_y) as a function of (x, y).

(c) Write equation of deflection curve and obtain deflections at free end. **[20M]**

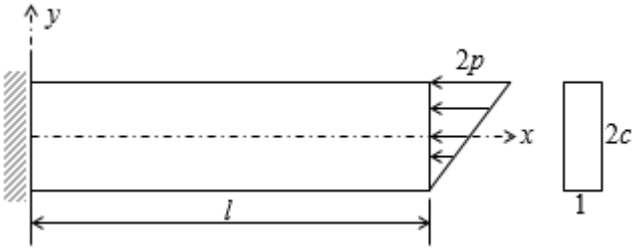

Fig Q2

Q3. Consider a curved cantilever beam of narrow rectangular cross-section with inner radius a and outer radius b ($b = 2a$ = 1 m) is subjected to end loadings as shown in **FigQ3**.

Note: *Specify each and every equation used and its reference from the text book.*

(a) Write the Airy's stress function for this loading **(b)** At the fixed end, write down the boundary conditions, which represents the loading in terms of stress components **(c)** Compute the *hoop stress* acting on an element *E*, which is lying at the outer edge of the fixed end. **[20M]**

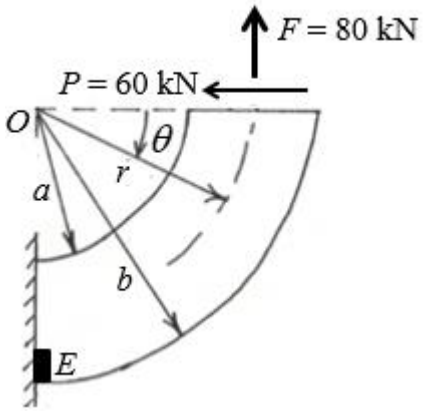

Fig Q3