Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2020

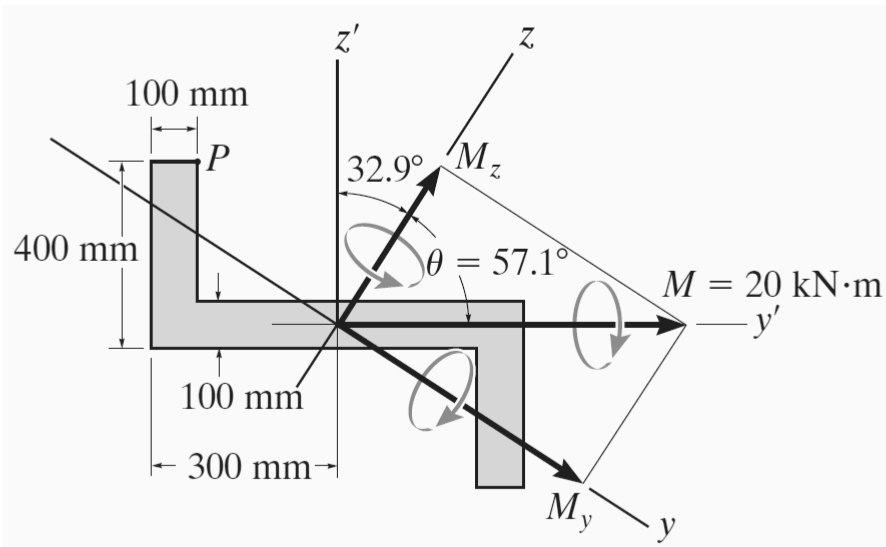
Course: Solid Mechanics **Semester: V**
Course Code: MECH3022 **Time: 03 hrs.**
Program: BTech- Mechanical **Max. Marks: 100**

SECTION A

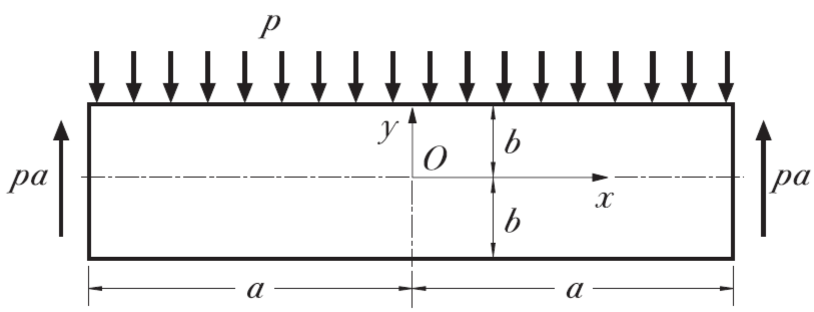
S. No.	Question Statement	Marks	CO
Q 1	Explain the properties of Kronecker Delta and Permutation symbol.	**5**	**CO1**
Q 2	Explain the summation convention.	**5**	**CO1**
Q 3	Describe plane stress and plane strain problems.	**5**	**CO1**
Q 4	Describe the types of boundary condition.	**5**	**CO1**
Q 5	Explain the properties of influence coefficient.	**5**	**CO1**
Q 6	State the Maxwell-Betti-Rayleigh's reciprocal theorem.	**5**	**CO1**

SECTION B

S. No.	Question Statement	Marks	CO
Q 7	Derive Castigliano's first theorem.	**10**	**CO2**
Q 8	Consider a problem with body forces, $f = \begin{Bmatrix} f_1 \\ f_2 \\ f_3 \end{Bmatrix} = \begin{bmatrix} -6Gx_2x_3 \\ 2Gx_1x_3 \\ 10Gx_1x_2 \end{bmatrix}$ where, $G = \frac{E}{2(1+2\upsilon)}$ and $\nu = \frac{1}{4}$ The displacement field is given as, $u = \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \end{Bmatrix} = \begin{bmatrix} C_1x_1^2x_2x_3 \\ C_2x_1x_2^2x_3 \\ C_3x_1x_2x_3^2 \end{bmatrix}$, determine the constants C_1, C_2 and C_3.	**10**	**CO3**
Q 9	With respect to axes $Ox_1x_2x_3$ the stress state is given in terms of the coordinates by the matrix, $\sigma_{ij} = \begin{bmatrix} x_1x_2 & x_2^2 & 0 \\ x_2^2 & x_2x_3 & x_3^2 \\ 0 & x_3^2 & x_3x_1 \end{bmatrix}$, Determine (a) the body force components as functions of the coordinates if the equilibrium equations are to be satisfied everywhere (b) the stress vector at point $P(1,2,3)$ on the plane whose outward unit normal makes equal angles with the positive coordinate axes.	**10**	**CO3**
Q 10	Derive the equilibrium equations for 2D stress condition in cylindrical coordinate system.	**10**	**CO2**

<table>
<tr><td>Q 11</td><td>Derive the expression of normal stress in unsymmetrical bending.</td><td>10</td><td>CO2</td></tr>
<tr><td colspan="4">SECTION-C</td></tr>
<tr><td rowspan="3">Q 12</td><td>The Z-section shown in Figure below is subjected to the bending moment of $M = 20$ kN-m. The principal axes y and z are oriented as shown, such that they represent the minimum and maximum principal moments of inertia, $I_y = 0.96\times10^{-3}$ m^4 and $I_z = 7.54\times10^{-3}$ m^4 respectively. Determine the normal stress at point P and the orientation of the neutral axis.

</td><td rowspan="3">20</td><td rowspan="3">CO3</td></tr>
<tr><td>OR</td></tr>
<tr><td>Determine the constants C_1, C_2, C_3 and C_4 in the Airy stress function

$$\phi = C_1x^2 + C_2x^2y + C_3y^5 + C_4x^2y^3$$

for the rectangular beam shown in figure. Also find out the corresponding stress functions.

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