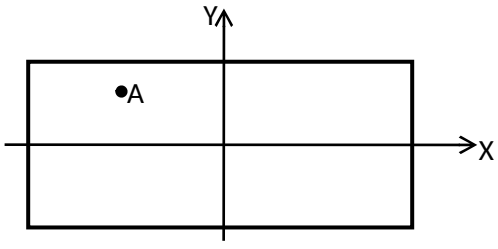
Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Mechanics of Materials **Semester: IV**
Program: B. TECH. Mechanical + ADE **Time: 03 hrs.**
Course Code: MECH2003 **Max. Marks: 100**

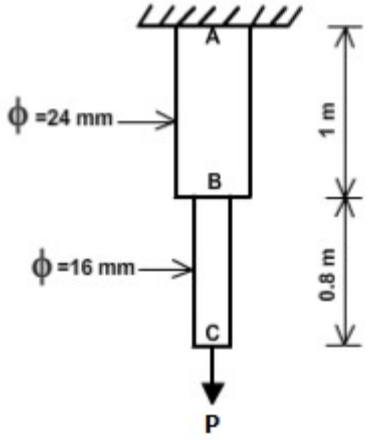
Instructions: All questions are compulsory. Internal choice is provided wherever applicable.

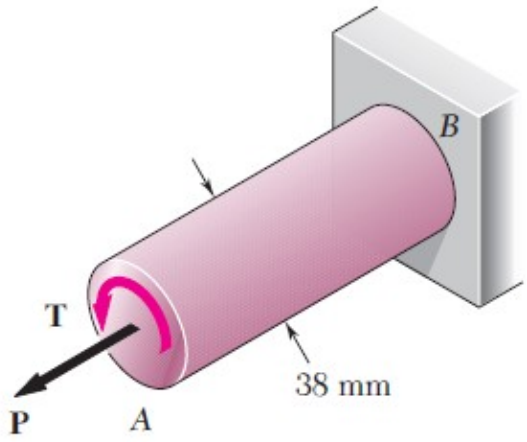
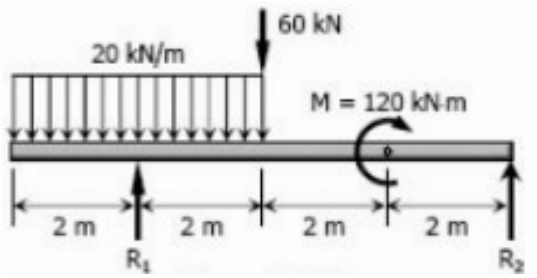
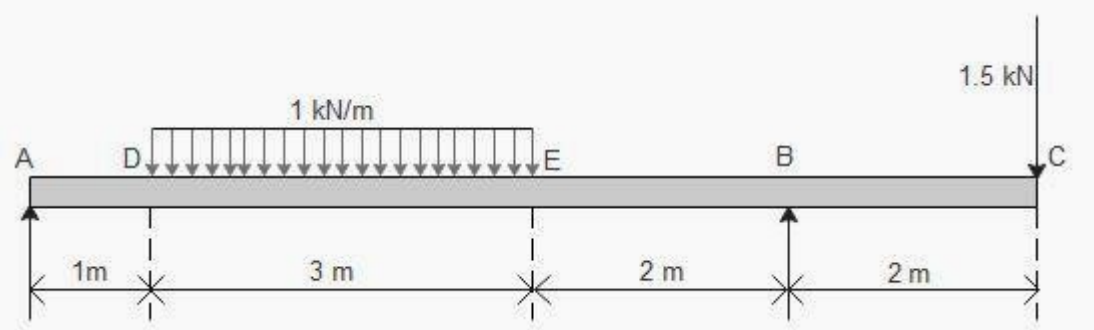
SECTION A

S. No.		Marks	CO
Q.1	What are the various assumptions of torsion equation? If a shaft has a diameter of 21 mm and length of 2.5 m then calculate the torsional rigidity of the shaft. Modulus of elasticity is 210 GPa and Poisson's ratio is 0.25.	**5**	**CO3**
Q.2	A cantilever beam has length L. Its rectangular cross section has breadth and height of b & h respectively. A vertical downward force P is acting at the mid-point of the cantilever beam. Find deflection and slope at the free end.	**5**	**CO1**
Q.3	A thin spherical shell of internal diameter 1.5 m and wall thickness 10 mm has an internal pressure of P. The modulus of rigidity is 70 GPa and Poisson's ratio is 0.3. The elastic limit of the material is 400 MPa and a factor of safety of 5 is used. Calculate the maximum value of P that can be applied. Also determine the corresponding change in volume.	**5**	**CO2**
Q.4	A cantilever beam has a length of 2 m and the cross section is shown below. The breadth and height of the cross section are 48 and 96 mm respectively. An axial tensile force of 5 kN is applied at a point A. The coordinates of the point A are (-24, 36). Find the equation of the neutral axis.  	**5**	**CO1**

SECTION B

Q.5	A hollow steel pipe has outside diameter 350 mm, wall thickness of 15 mm and the length of 4.5 m is fixed at both the ends. Calculate the safe load using Rankine formula for factor of safety of 3. Given that yield stress in compression is 400 MPa,	**10**	**CO1**

	Young's modulus is 200 GPa and Rankine constant $\propto = \frac{1}{5000}$.		
Q.6	Calculate the efficiency of a double riveted double cover butt joint if the plate thickness is of 16 mm. The allowable stresses in tension, shearing and crushing are 100 MPa, 80 MPa and 200 MPa respectively. Also calculate rivet diameter, gross diameter and pitch length.	**10**	**CO3**
Q.7	The state of stress at a point in a mechanical component is given as, $\sigma_{ij} = \begin{bmatrix} 50 & -30 \\ -30 & -30 \end{bmatrix} MPa$ Determine the principal stresses, the principal plane, the maximum shear stress and the plane of maximum shear stress using Mohr's circle (graph paper provided). OR The state of stress at a point in a mechanical component is given as follows, $\sigma_x = 72\ MPa$, $\sigma_y = -32\ MPa$, $\tau_{xy} = 24\ MPa$.Using Mohr's circle determine, (A) The principal stresses. (B) The principal plane. (C) The stress components$\sigma_{x'}, \sigma_{y'}, \tau_{x'y'}$ if x'-axis makes an angle of 30° with x-axis (graph paper provided).	**10**	**CO4**
Q.8	Yield strength of the material is σ_{yp} = 450 MPa and a factor of safety of 3 is used. An external load P is applied gradually at the end C. Find the maximum value of the force. Find the total strain energy absorbed by the compound rod ABC. Also determine the strain energy densities i.e. resilience in the parts AB and BC. Neglect mass of the rod. Take E=200 GPa.  	**10**	**CO2**
	SECTION-C		
Q.9	The 38 mm diameter shaft *AB* is made of a grade of steel for which yield strength is σ_{yp} = 350 MPa. A force P = 60 kN is applied as shown. Determine the magnitude of the torque T applied when yielding occurs according to, (A) Maximum principal stress criterion (B) Maximum-distortion-energy criterion. (C) Maximum-shearing stress criterion,	**20**	**CO4**

	Modulus of Elasticity, E= 200 GPa, Poisson's Ratio = 0.3 and FOS = 4.  		
Q.10	(A) A beam is used to carry a loading as shown below. The support reactions are represented by R_1 and R_2. The rectangular cross section of the beam has breadth of 60 mm and height of 80 mm. Modulus of elasticity of the beam material is 200 GPa. Determine slope at the first support and deflection at the mid-point of the beam. [12 marks]  (B) Plot SFD and BMD for the beam and loading shown above and also locate the point of contra-flexure (if any). Determine the maximum bending stresses in tension as well as in compression at the point of maximum bending moment along the length of the beam. [8 marks] OR (B) Plot SFD and BMD for the beam and loading shown below and also locate the point of contra-flexure (if any). The beam is supported at points A and B. Determine the maximum bending stresses in both tension and compression at the point of maximum bending moment. The rectangular cross-section of the beam has breadth and height of 20 mm and 30 mm respectively. [8 marks]  	**20**	**CO1**