Name : **Enrolment No :**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

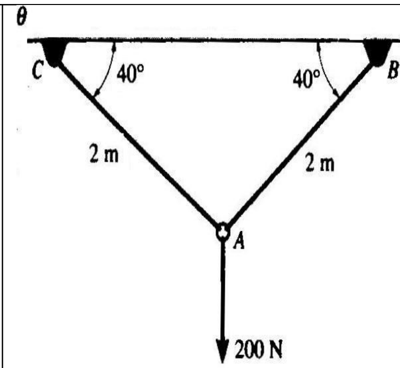
End Semester Examination, December 2018

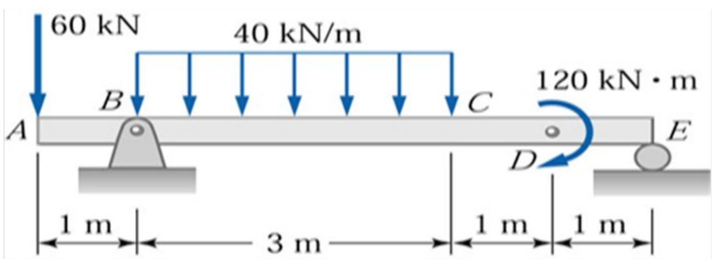
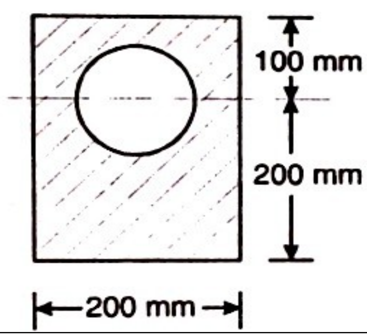
Programme Name : B. Tech. ASE and ASE + AVIONICS **Semester : III**
Course Name : Strength of Materials **Time : 03 Hrs**
Course Code : MECH 2012/GNEG 217 **Nos. of pages : 03** **Max. Marks : 100**

Instructions:	**This question paper has 3 sections; Section A, Section B and Section C. Make use of sketches/plots to elaborate your answers. Assume any** MISSING **data appropriately. Brief and to the point answers are expected.**

SECTION A (4x5=20M)
Attempt all questions

S. No.		Marks	CO
Q 1	A square element is stressed with two mutually perpendicular normal stresses of 400 MPa (T) & 50 MPa (C) and unknown original and complementary shear stresses on these planes. If the normal stress on the diagonal plane is zero, determine the magnitude of shear stress on the diagonal plane and principal stresses.	**4M**	**CO4**
Q 2	A steel bar of 25 mm diameter and gauge length of 250 mm was tested for tension and for torsion. A tensile load of 50 kN produced an extension of 0.13 mm and a torque of 200 N-m produced 1° of twist in the bar. Determine (i) Modulus of Elasticity (ii) Modulus of Rigidity (iii) Poisson's Ratio (iv) Bulk Modulus.	**4M**	**CO1**
Q 3	Determine the efficiency of a triple riveted lap joint in which the rivets are arranged in zig-zag pattern. The thickness of the plates is 25 mm and safe values of tensile stress, shearing stress and bearing stress are 90 MPa, 65 MPa and 120 MPa respectively.	**4M**	**CO1**
Q 4	An unknown weight falls through a height of 10 mm on a collar rigidly attached to the lower end of a vertical bar 5m long and 600 mm^2 in cross section. If the maximum extension of the rod is to be 2.0 mm, what is the magnitude of the unknown weight? Take E = 180 GPa	**4M**	**CO4**

Q 5	Two identical rods AB and AC each of length 2m, diameter 20 mm and negligible weight are hinged at point B and C; both points at same level as shown in figure. Other ends of both the rods are pin joined at point A. A downward vertical force of 200 N is applied gradually at joint A. Using strain energy concept, determine the vertical displacement of the point A. Given E = 210 GPa.		**4M**	**CO1 CO4**
SECTION B (5x8=40M) **Attempt all questions**				
Q 6	A solid alloy shaft 60 mm in diameter is coupled with a hollow steel shaft of the same external diameter in series. If the angle of twist per unit length of the steel shaft is 80% of that of alloy shaft, find the inner diameter of the steel shaft. What will be the speed of rotation to transmit 300 kW if the limiting stresses in the alloy and steel are to be 50 MPa and 72 MPa respectively. The modulus of rigidity for steel is twice to that of alloy.		**8M**	**CO3**
Q 7	A beam of span 6m has one support at the left and the other support at a distance of 2m from the right end. The beam carries a UDL of 10kN/m over the entire span. Draw the SFD and BMD and prove that the middle point of the beam is the point of contra flexure. This beam has a rectangular cross-section with base of 80 mm. Determine the depth/height of the cross-section, if maximum bending stress is limited to 150 MPa.		**8M**	**CO2**
Q 8	Two cast iron coloumn each of 80 x 160 mm^2 rectangular cross section and 4.0 m long are loaded with one end fixed and other hinged. They share equally the total load carried by them. Using Rankine's formula, determine the diameter of single solid circular coloumn of cast iron of same length and with same end conditions to replace both of them. Also calculate the percentage saving in material. Take Rankine's constant α = 1/1600 and crushing stress σ_c = 500 MPa.		**8M**	**CO2**
	OR			
Q 8	A 4 m steel column made of an unequal I section 300 mm deep with upper flange width 150 mm and lower flange width 100 mm is fixed at both ends. The thickness of the flanges is 10 mm and web is 20 mm. Using secant formula, determine the maximum eccentricity for a load of 600 kN from the Y-Y axis, if the maximum permissible stress is 100 MPa. Given E = 200 GPa.			
Q 9	A metallic plate specimen is tested under direct stresses acting in two mutually perpendicular directions. The strains in two principal directions are recorded as $\varepsilon_1 = 7.81 \times 10^{-4}$ and $\varepsilon_2 = 1.94 \times 10^{-4}$. Determine the Yield stress for the material of the plate, if failure occurs according to Maximum Shear Strain Energy per Unit Volume theory. Given E = 72 GPa and Poisson's ratio v = 0.33.		**8M**	**CO1 CO4**
Q 10	An equal double overhanging uniform beam of length 'L' is simply supported		**8M**	**CO2**

	on a span ‘l’ i.e. L > l. Find the ratio of L / l so that the upward deflection at each end equals the downward deflection at middle point, if a point load acts at the middle point of the beam.		
	SECTION-C **Attempt all questions**		
Q 11 (a)	A double overhanging beam ABCDE has equal overhung AB and DE, each of 2 m on both sides. It is simply supported at B and D such that span BD is 6m and the total length of beam is 10 m. It carries two equal point loads each of 75 kN at the ends A and E together with third point load of 100kN at the mid-point C. In addition, it also carries a uniformly distributed load of 50 kN/m between the supports. Determine the deflection at the mid-point and at the ends of the beam either by Macaulay’s method or by Area Moment method. Given E = 200 GPa. **OR**	**12M**	**CO2**
Q 11 (a)	A single overhanging simple supported beam is loaded as shown in figure below. Using Macaulay’s method, determine the deflection of the point A and point D. Given E = 200 GPa. 	**12M**	
Q 11 (b)	In both the cases, the beam has a rectangular cross-section where a circle of 70 mm diameter has been removed as shown in figure below. Determine the magnitude of shear stress at four surfaces; top of the circle, centre of the circle, bottom of the circle and neutral axis for a cross-section between span BC at a distance of 0.5 m from point B. 	**8M**	**CO2**
Q 12	A thin cylinder closed at both the ends has 120 mm internal diameter and 5 mm wall thickness. This cylinder has a circumferential joint of efficiency 75% and subjected to an internal pressure of 5 N/mm^2. Determine the magnitude of longitudinal and circumferential stresses induced in the material. Also calculate the increase in length, diameter and volume of the cylinder. Take Young’s Modulus E = 200 GPa and Poisson’s ratio v = 0.3. Neglect the effect	**7M**	**CO3** **CO4**

	of radial stress. This cylinder is now subjected to a torque of 2.37 kN-m. For this plane stress condition of cylinder material, determine analytically: (a) Principal stresses σ_1 and σ_2 (b) Maximum shear stress τ_{max} (c) direction of principal planes and (d) Normal and shear stresses on oblique plane 30° counter clockwise to the axis of cylinder.	**7M**	
	Also, draw Mohr's stress circle for this plane stress condition and compare your previous answers with those obtained by Mohr's stress circle. Assume shear couple along the circumference to be positive.	**6M**	