UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: M. Tech. (Automation & Robotics Engineering) Semester: I
Subject (Course): Mechanics and Mechanisms Max. Marks: 100
Course Code : MECH7002 Duration: 3 Hrs
No. of page/s:

Section - A (60 Marks)

Q.1 A homogeneous bar with a cross sectional area of 500 mm² is attached to rigid supports. It carries the axial loads $P_1 = 25$ kN and $P_2 = 50$ kN, applied as shown. Determine the stress in segment BC and the deflections of B and C. Modulus of elasticity is 200GPa. [10 marks]
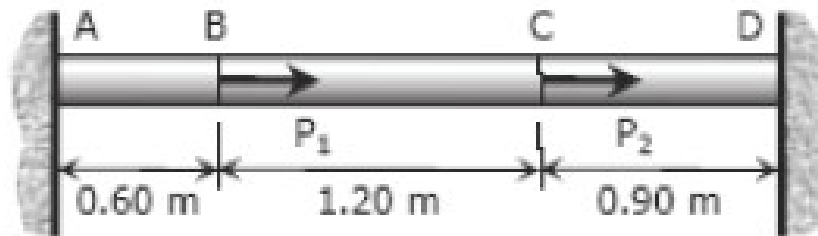
Q.2 A steel propeller shaft of diameter 4 cm is used to transmit power at 120 rpm. If maximum angle of twist is limited to 1° per meter and the maximum shear stress is limited to 80 MPa then calculate the maximum power that can be transmitted using this shaft. The modulus of shear of shaft steel is 80 GPa. [10 marks]

**Q.3** Steel railroad reels 10 m long is laid with clearance of 3 mm at a temperature and 15°C. At what temperature the rails will just touch? What stress will be induced in the rails at that temperature if there was no initial clearance? Assume α=11.7 μm/m.°C and E=200 GPa. [10 marks]
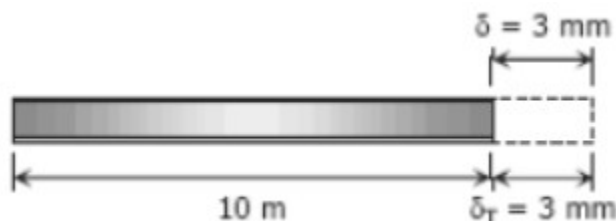

Q.4 Determine principal stresses, principal plane and stress components in a direction that makes an angle of 40° with x-axis for the state of stress given below. [10 marks]

$$\sigma_x = 90 \text{ MPa}, \sigma_y = 10 \text{ MPa}, \tau_{xy} = \tau_{yx} = 30 \text{ MPa}$$

Q.5 Determine degrees of freedom for the following systems, [10 marks]

(A)	(B)
(C)	**(D)**
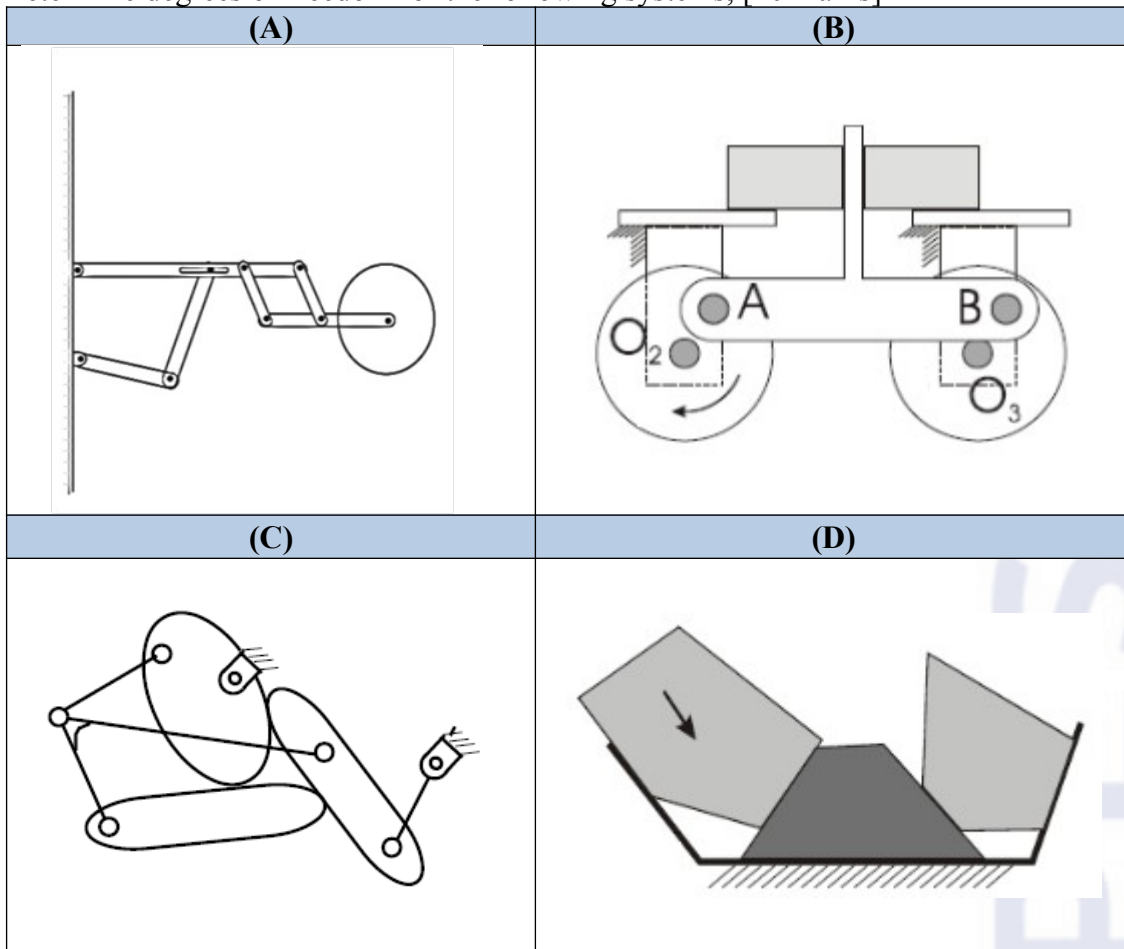
Q.6 Determine the simplest resultant of the force system shown below and locate the point on the x-axis through which it passes. [10 marks]
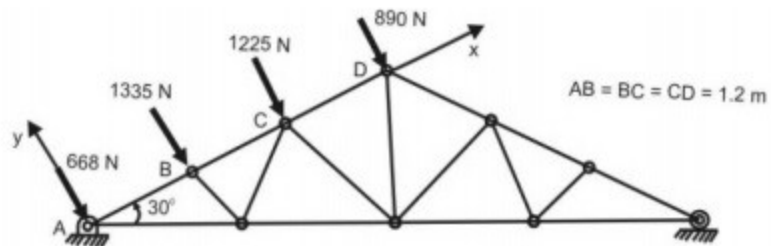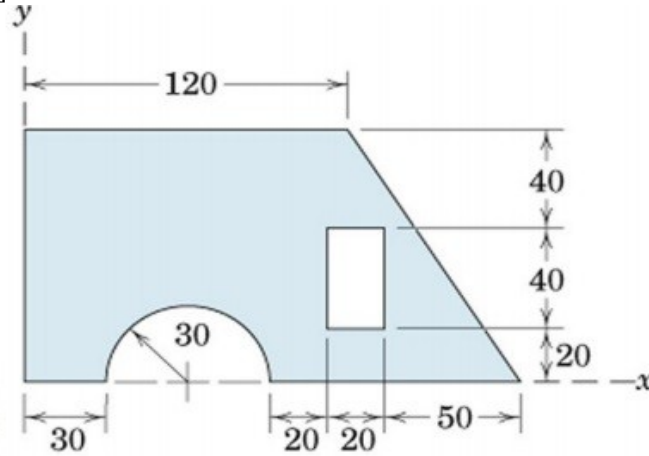

Section - B (40 Marks)

**Q.7 (A)** Locate the centroid of the shaded area. [5 marks]
(B) Determine the second moments and product of are about the centroidal axes. [10 marks]

(C) Also determine principal axes with origin at the centroid, principal second moments and product of area.   [5 marks]

Q.8 (A) Plot shear force diagram (SFD) and bending moment diagram (BMD) for the simple supported beam shown below. Also locate the point of contra-flexure, if any. [10 marks]

(B) Determine slope & deflection of points C & D. Given E = 200 GPa and I = 8.26X10^{-4} m^4. [10 marks]
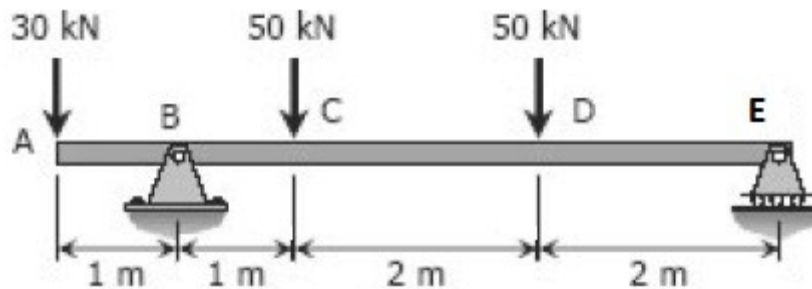
OR

An overhanging beam ABC supported at A and B is loaded as shown below.
(a) Determine deflection and slope at free end C [12 marks]
(b) Plot shear force and bending moment diagrams and locate point of contra-flexure if any. [8 marks]
Take E= 200 kN/mm^2 and I= 450 cm^4.