B.E. MECHANICAL ENGINEERING EXAMINATION, 2018
(1st Year, 2nd Semester)
ENGINEERING MECHANICS - II

Time: Three Hours **Full Marks: 100**

Any missing data may be assumed with suitable justification
Marks are indicated in the square bracket against each question
For question Q5a, the figure should be drawn in graph paper

PARTS OF THE SAME QUESTION MUST BE ANSWERED TOGETHER

GROUP – A (CO1)

Q1. Answer any four: **[5 × 4 = 20]**

(a) What do you mean by statically indeterminate problems? Explain with an example.

(b) Discuss Wahl's corrections for close-coiled helical springs.

(c) What do you mean by torsional rigidity and flexural rigidity?

(d) Explain pure bending of beam.

(e) Prove that for a beam with rectangular cross-section and subjected to some transverse loading, the maximum transverse shear stress is 1.5 times the average shear stress developed in the section.

(f) Briefly explain strain rosette.

GROUP – B (CO2)

ANSWER ANY THREE QUESTIONS

Q2. **[10+10]**

(a) The circular section stepped rod ABC is made of Aluminum (**Fig. Q2a**) for which E=70 GPa. Knowing that P=6 kN and Q=42 kN, find the stresses in the segments AB and BC. Also find the displacement of point A.

(b) For the composite bar made of bronze and aluminum (**Fig. Q2b**), a 0.5 mm gap exists when the temperature is 30^{0}C. Determine the temperature at which the normal compressive stress in the aluminum bar will be equal to 90 MPa. For bronze bar: A=1500 mm^2, E =105 GPa, α =21.6×10^{-6}/^{0}C; For aluminum bar: A=1800 mm^2, E =73 GPa, α =23.2×10^{-6}/^{0}C.

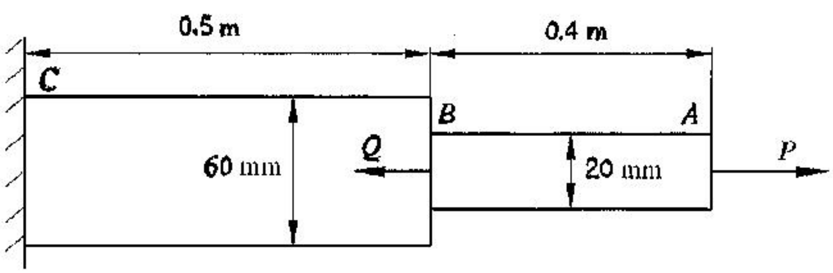

Fig. Q2a

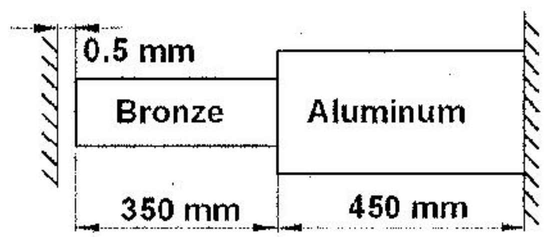

Fig. Q2b

[Turn over

Q3. [10+10]

(a) A 2.5 m long steel shaft (G=77.2 GPa) of 30 mm diameter rotates at a frequency of 30 Hz. Determine the maximum power that the shaft can transmit, knowing that the allowable shear stress is 60 MPa, and that the angle of twist must not exceed 7.5^0.

(b) Two close-coiled helical springs wound from the same wire with same number of coils but with different mean coil radii are coaxially assembled as shown in **Fig. Q3b** and compressed between rigid plates at their ends. Calculate the maximum shear stress induced in each spring if the wire diameter d=12 mm and P=500 N. The mean coil radii for the outer and inner springs are 100 mm and 75 mm respectively.

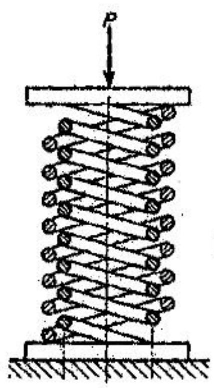

Fig. Q3b

Q4. [12+8]

(a) For a rectangular section beam loaded as shown in **Fig. Q4**, draw the complete shear force and bending moment diagrams.

(b) For the beam shown in Fig. **Q4**, determine the maximum normal stress and the maximum shear stress developed in the beam.

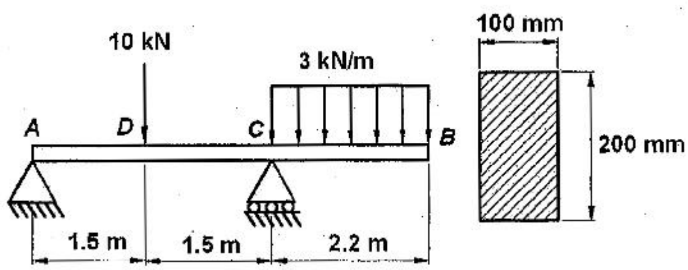

Fig. Q4

Q5. [10+10]

(a) For the state of plane stress shown in **Fig. Q5a**, draw the Mohr's circle [should be drawn in graph paper and in scale] for stresses of the element. Then, from Mohr's circle, (i) find the principal stresses and the principal planes, (ii) find the value and the plane of maximum in-plane shear stress. Show the results of (i) on a properly oriented element in body plane.

(b) The readings from a 45^0 strain rosette are ε_a=100 μ, ε_b= 300 μ and ε_c= -200 μ. If the material properties are E = 180 GPa and ν = 0:28, determine the principal stresses and their directions.

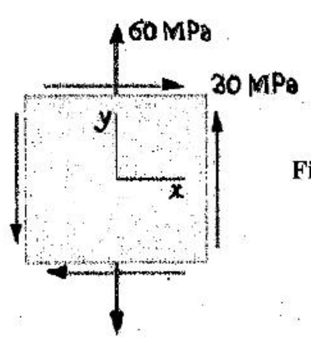

Fig. Q5a

GROUP – C (CO3)

Q6. **[10]**

Drawing suitable neat figures, derive the governing equation involving membrane stresses for an axi-symmetric thin-walled pressure vessel subjected to internal pressure.

OR

A 900-mm length of a 20-mm-diameter steel pipe extends horizontally from a concrete wall. A workman fits a pipe wrench to the end of the pipe and pushes downward with a force P on the end of the handle, which is 375 mm long. If the section modulus for the pipe cross-section is 1100 mm^3 and the allowable stress in shear is 140 MPa, what is the safe value of the force P?

GROUP – D (CO4)

Q7. **[10]**

Deduce the governing differential equation of a single-degree-of-freedom spring-mass-damper system and find its general solution. Then develop the solution for the case of underdamped motion.

OR

A spacecraft with a mass of 800 kg is travelling in a circular orbit 6000 km above the earth. It is desired to change the orbit to an elliptical one with a perigee altitude of 3000 km as shown in **Fig. 7**. The transition is made by firing the retro-engine at A with a reverse thrust of 2000 N. Calculate the required time t for the engine to be activated.

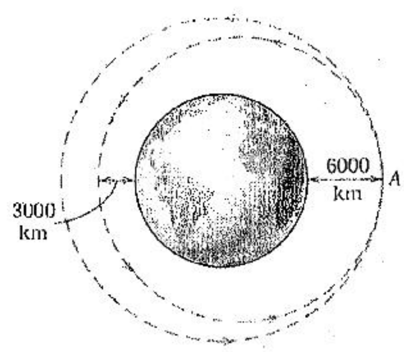

Fig. 7

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