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UNIVERSITY EXAMINATIONS 2024/2025

THIRD YEAR FIRST SEMESTER EXAMINATION FOR DEGREE OF BACHELOR OF TECHNOLOGY IN ELECTRICAL ENGINEERING

EMT 3301: SOLID AND STRUCTURAL MECHANICS II

DATE: JANUARY 2025

TIME: 3 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- a) Outline the important points for drawing Bending moment and Shear Force diagram [6 marks]
- b) Draw the shear force diagram and bending moment diagram for a cantilever loaded as shown in Fig Q1, also determine the point of contraflexure [14 marks]

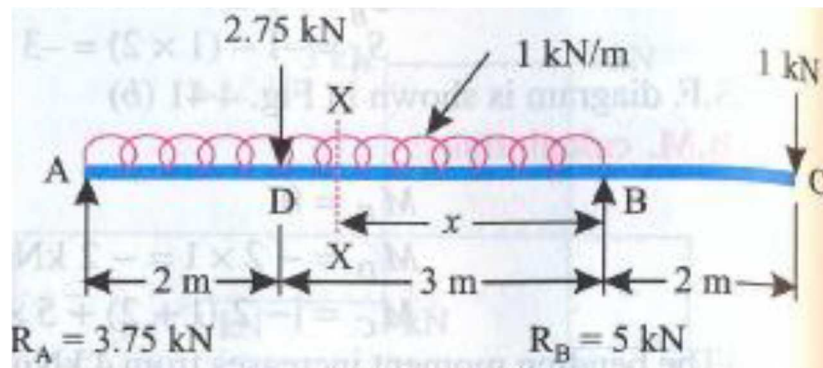


Fig Q1

- c) With the help of sketches, explain five (5) types of beams [10 Marks]

QUESTION TWO (15 MARKS)

- a) What are composite beams? [2 Marks]
- b) Explain any three (3) types of composite beams [3 Marks]
- c) A timber joist 100 mm x 200 mm is reinforced on its top and bottom surfaces by steel plates 15 mm thick by 100 mm wide. The composite beam is simply supported over a span of 4 m and carries a uniformly distributed load of 10 kN/ m. Determine the maximum direct stress in the timber and in the steel and also the shear force per unit length transmitted by the timber-steel connection. The Young's modulus of steel is 15 times that of timber [10 Marks]

QUESTION THREE (15 MARKS)

- a) What are the assumptions made in *Lame's theory*? [4 Marks]
- b) A thick-walled closed end cylinder is made of an aluminium alloy ($E = 72 \text{ GPa}$, $\nu = 0.33$), has inside diameter of 200mm and outside diameter of 800 mm. The cylinder is subjected to internal fluid pressure of 150 MPa. Determine the principal stresses and maximum shear stress at a point on the inside surface of the cylinder. Also determine the increase in inside diameter due to fluid pressure [11 Marks]

QUESTION FOUR (15 MARKS)

- a) For cantilever beam with concentrated load W at free end, show that the maximum slope is given by $\theta_{\max} = -\frac{Wl^2}{2EI}$, while maximum downward deflection $y_{\max} = \frac{Wl^3}{3EI}$ [5 Marks]
- b) A cantilever of 3 m length and of uniform rectangular cross section 150 mm wide and 300 mm deep is loaded with a 30 kN load at its free end. In addition to this, it carries a uniformly distributed load of 20 kN per metre run over its entire length.

Take $E = 210 \text{ GN/m}^2$, Calculate:

- i. The maximum slope and maximum deflection [6 Marks]
- ii. The slope and deflection at 2 m from the fixed end [4 Marks]

QUESTION FIVE (15 MARKS)

A close coiled helical spring is to have a stiffness of 900 N/m in compression, with a maximum load of 45 N and a maximum shearing stress of 120 N/mm². The solid length of the spring (i.e coils touching) is 45 mm. Find:

- i. The wire diameter [7 Marks]
- ii. The mean coil radius [7 Marks]
- iii. The number of coils [6 Marks]

Take the modulus of rigidity of material of the spring as 0.4×10^5 N/mm².

