MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 303: SOLID AND STRUCTURAL MECHANICS 11

DATE: 18/4/2023 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS

This paper contains FIVE questions

Question ONE is **compulsory** and carries 30 Marks.

Questions TWO – FIVE carries 20 Marks each. **Answer any Two.**

QUESTION ONE (COMPULSORY) (30 MARKS)

a) A horizontal beam AB 6 m long is hinged at point A and freely supported at B and subjected to forces as shown in Fig Q 1 a).

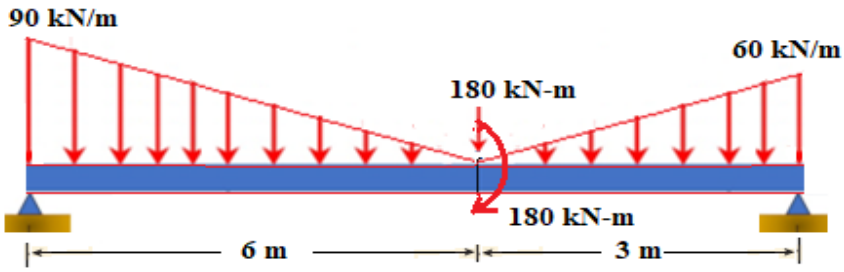

Fig. Q 1 a)

Using a suitable scale, draw the shear force diagram. (8 marks)

b) A beam of length 6 m carries uniformly varying loads as shown in Fig. Q 1 b). Determine the reactions of the beam to this load.

(4 marks)

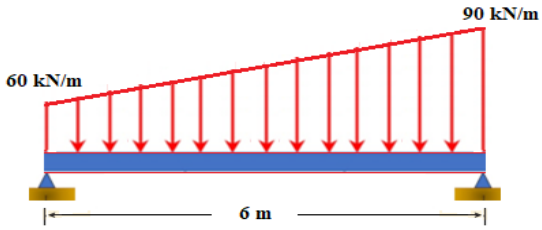

Fig. Q 1 b)

c) Starting from first principles, derive the elastic bending formula (8 marks)

d) Derive the deflection equation for the following cantiliver. (7 marks)

Fig. Q 1 d)

e) A laminated spring 1 m long is made up of plates each 50 mm wide and 10 mm thick. If the bending stress in the plates is limited to 100 MPa, how many plates are required to enable the spring to carry a central point load of 2 kN. If modulus of elasticity for the spring material is 200 GPa, what is the deflection under the load? (3 marks)

QUESTION TWO (20 MARKS)

a) A beam 5 m long shown in Fig Q2 a) is loaded by an inclined load of 10 kN. If the angle of inclination θ is 38.87^0; and the breadth and height are 200 mm and 300 mm respectively;

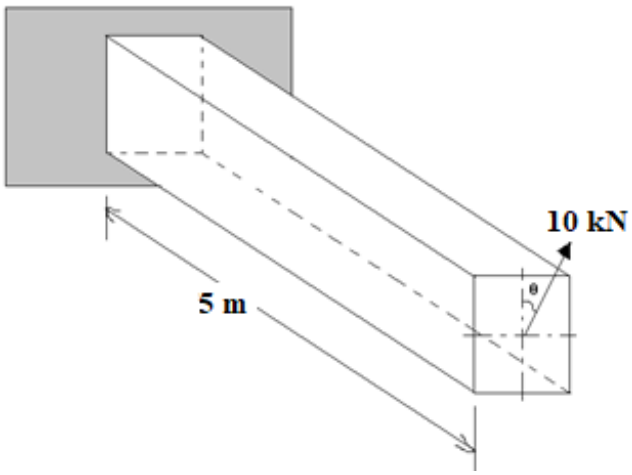

Fig. Q 2 a)

i) Find the orientation of the neutral axis (5 marks)

ii) Calculate the maximum stress in the beam (4 marks)

b) Fig Q2 b) shows a statically indeterminate pin-jointed frame where all members remain elastic, have the same Young's Modulus E and cross-sectional area a. If there are no initial lacks of fit of the members find the force in the member AC using the Principle of Virtue. Take member AC as the redunant frame. (11 marks)

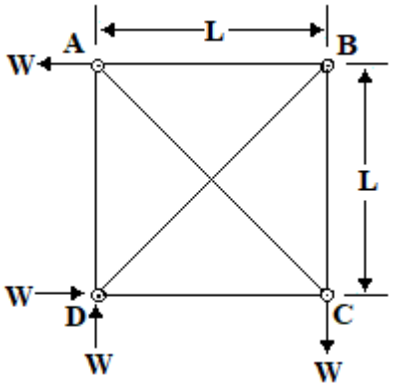

Fig. Q 2 b)

QUESTION THREE (20 MARKS)

A simply supported beam of length 3 m carries a uniformly varying load of intensity 25 kN/m and is made of timber with an allowable bending stress of $\sigma_{all} = 12\ MPa$. The beam has a rectangular cross section with depth twice the breadth. Determine;

a) The reaction forces at the supports (3 marks)

b) Draw the shear force and bending moment diagrams for the beam (12 marks)

c) The optimum dimensions of the beam (5 marks)

QUESTION FOUR (20 MARKS)

The beam shown in Fig. Q 4) is made up of steel. If the allowable shear stress is 35 MPa;

a) Check the suitability of the section (16 marks)

b) If you designed such a structure assuming that the web carries all the shear stress, what percentage error would you get? (4 marks)

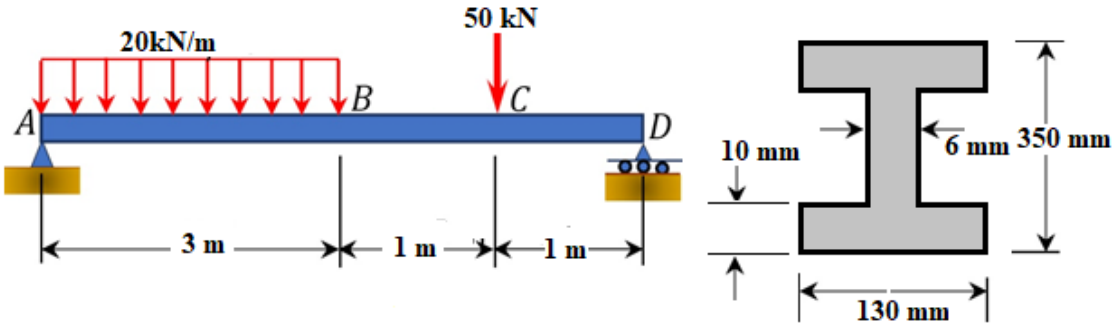

Fig. Q 4)

QUESTION FIVE (20 MARKS)

Derive an expression for maximum deflection of the beam shown in Fig Q5.

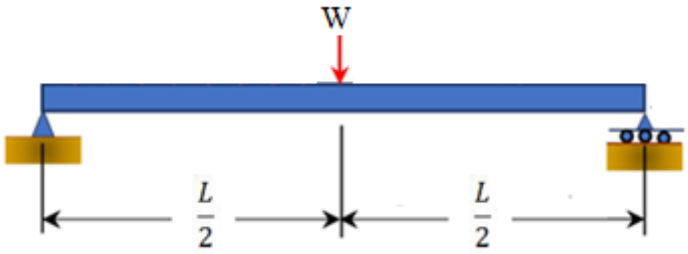

Figure Q5