



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING & CIVIL ENGINEERING
UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 4211 : STRENGTH OF MATERIALS I

ORDINARY EXAMINATION

SERIES: JANUARY 2025

TIME: 2 HOURS

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of five questions.

Attempt question ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

QUESTION 1 (COMPULSORY) 30 marks

- a) For the elevation of the beam shown on figure 1(a), determine the reaction at supports and draw the **shear force diagram to determine the point of contra flexure**, from this point, determine the maximum bending moment.

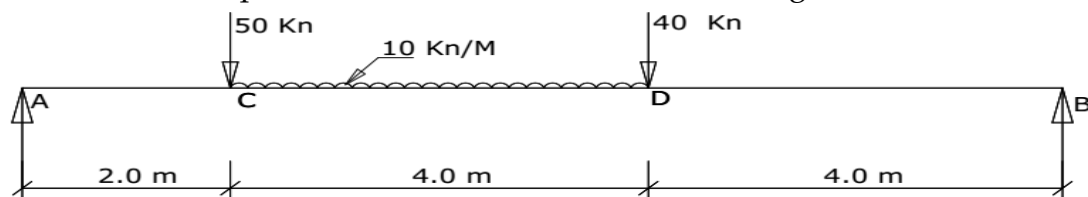


Figure 1(a)

(10marks)



- b) For the bar on figure 1(b) below which is applied to several axial loads P_1 , P_2 , P_3 and P_4 . Determine the magnitude of the force P_2 and the overall extension of the bar.

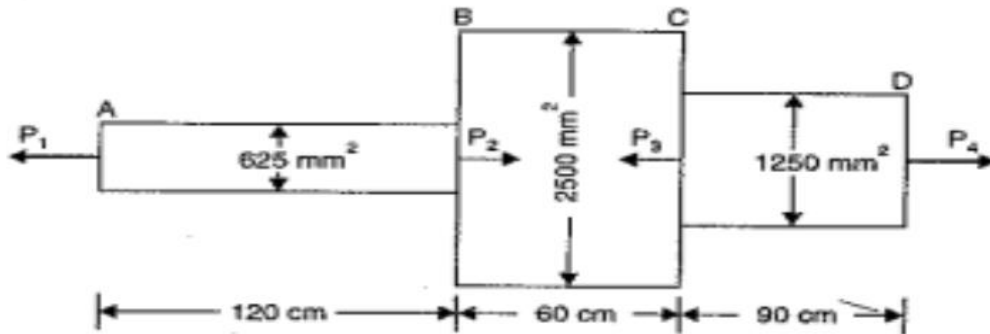
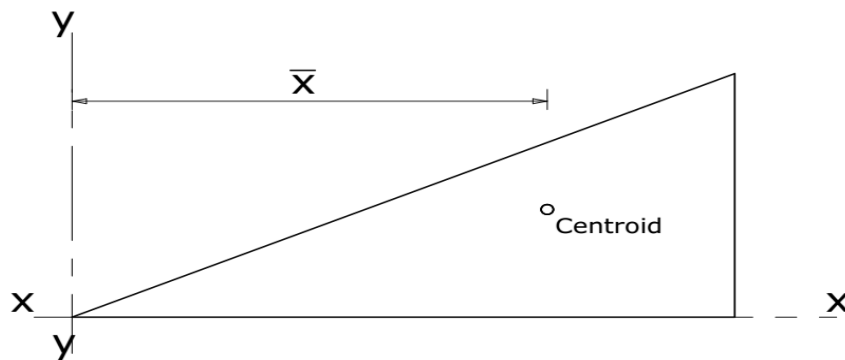


Figure 2(b)

(10 marks)

- c) Using the integration method and figure 1(c), derive an expression for centroid of a triangle from y-y axis.



(4 marks)

Figure 3(c)

- d) A bar of rectangular section $20\text{mm} \times 30\text{mm}$ carries an axial force of 10Kn . Determine the normal and shear force on plane inclined at 30° to the axis of the bar as shown on figure1 (d) below. Also determine the magnitude and nature of the normal and shear stresses on the inclined plane.

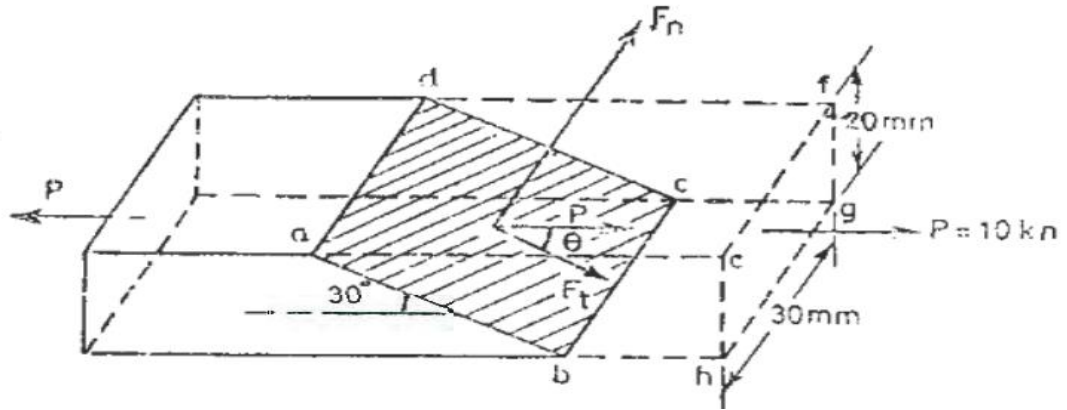


Figure 4(d)

(6 marks)

QUESTION 2

- a) A circular brass bar of 12mm diameter is tested under tension. If the increase in gauge length is 0.12 mm, determine the stress developed in the bar. What is the change in diameter?
- b) Figure 2(a) shows a two tie rods jointed through a pin of diameter d . The tie rods system transmits a tension force of 10 Kn. Determine the diameter of the pin, if the shear stress in the pin is not to exceed $100\text{N}/\text{mm}^2$.

(6 marks)

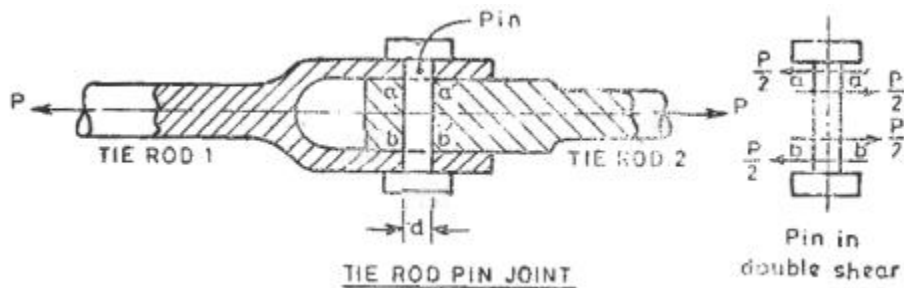


Figure 2(a)

(3marks)

- c) An Aluminum alloy specimen 12.5 mm diameter and 5 mm cm gauge length was tested under tension. During the first part of the test, following readings were recorded.

Load (Kg)	0	750	1000	1250	1500	1750	2000
Extension (mm)	0	0.327	0.450	0.568	0.756	0.120	0.216

On a graph paper, plot the load extension diagram and determine the following values.

- i) Young modulus of elasticity
- ii) Limit of proportionality
- iii) 0.1% proof stress.

(11 marks)

QUESTION 3

- a) List the **six** assumptions made in the theory of simple bending and **CLEARLY** explain the theory of simple bending and derive an expression for bending stress. Use well illustrated sketches.

(10 marks)

- b) For figure 3 (a), use the integration method to show that the moment of inertia of a rectangular section about Y-Y axis may be obtained as $\frac{db^3}{12}$

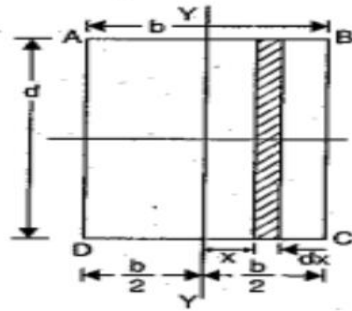


Figure 3(a)

(4 marks)

- C) A semi-circle area is removed from a trapezoid as shown in figure 3(b). Determine the centroid of the remaining area

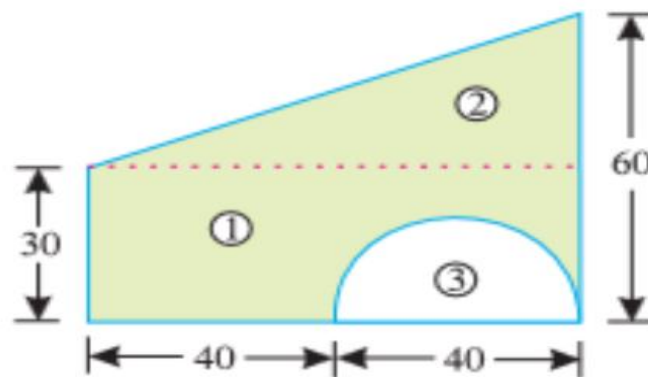


Figure 3(b)

(6 marks)

QUESTION 4

- a) On a steel bar specimen of 15 mm diameter and 150 mm gauge length, when tested as a tensile test specimen, a force of 15 Kn produce an extension of 0.063 mm. When the specimen is under torsion, a twisting moment of 694 Nm produces an angular twist of 0.15 degree. Determine the poisson's ratio for the material of the bar.

(8 marks)

- b) A flat steel bar 2.5 cm wide and 5 mm thick is placed between two aluminium alloys flats, each 2.5 cm wide and 10 mm thick to form a composite bar section of 25mmx25 mm. The three flats are fastened together at their ends. An axial tensile load of 200 kg is applied to the composite bar. What are the stresses developed in steel and aluminium alloy.

Take $E_{st}=2100$ tonnes/cm²

$E_{Al}=700$ tonnes/cm²

(6marks)

- c) In order to determine the internal diameter. A hollow steel tube of length 3.5m and external diameter 120 mm was subjected to a tensile load of 400kN and an extension of 2.0mm was recorded. Given the modulus of elasticity of steel is 200GPa, determine the internal diameter. (6marks)

QUESTION 5

- a) Figure 5(a) shows rectangular block of 80mmx60mmx40mm fixed at the base is subjected to a shear force of 240 Kn at the top surface. Considering that the shear stress is proportional to the shear strain. Determine;
- Shear angle
 - Shear stain energy for unit volume
 - Total shear strain energy for the block.
- Given that, Modulus of rigidity (G) = 840×10^2 N/mm². (12 marks)

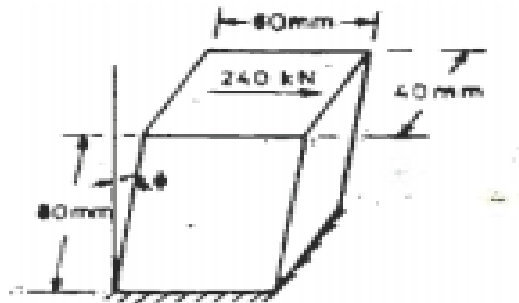


Figure 4(a)

- b) Figure 4(a) shows the stress at a point on two planes perpendicular to each other. Determine the position of the plane AB such that shear stress on this plane is zero. What will be the normal stress on such a plane?

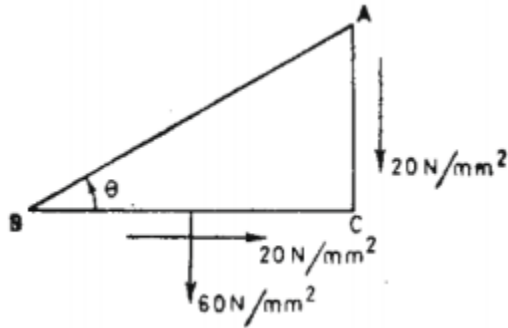


Figure 4(a)

(8 marks)