NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF TECHNICAL AND ENGINEERING EDUCATION AND TRAINING

PTE2147 STRENGTH OF MATERIALS

Main Examination

November 2024

This examination paper consists of FOUR (4) printed pages

Time allowed:	3 hours
Total marks:	100
Special Requirements:	Nil
Examiner:	Mr. A. Sithole
External Examiner:	Dr. Kahanji

INSTRUCTIONS

1. Answer any **FOUR** questions.
2. Sub-division marks are shown in brackets
3. Begin each question on a fresh page and number it.
4. Unless otherwise stated, all dimensions are in millimetres. Dimensions not given are left to your discretion.
5. Credit will be given for accuracy, legibility and neatness.

MARK ALLOCATION

QUESTION	MARKS
1	25 marks
2	25 marks
3	25 marks
4	25 marks
5	25 marks
6	25 marks

Question 1.

a. Define the terms: i. hoop stress $\qquad$ [1 mark]

                ii. Hooke's law $\qquad$ [1 mark]

                iii. Poisson's ratio $\qquad$ [1 mark]

b. Describe with the aid a diagram the stress vs. strain relationship for a mild steel specimen. Explain all the salient points observed on stress-strain curve diagram.

[10 marks]

c. A steel rail is 12m long and is laid at a temperature of 18°C. The maximum temperature expected is 40°C.

i) Estimate the maximum gap between two rails rails to be left so that the temperature stresses do not develop. [3marks]

ii) Calculate the temperature stresses developed in the rails, if a) No expansion joint is provided. b) if a 1.5mm gap is provided for expansion. [4marks]

iii) If the stress developed is 20N/mm^2. What is the gap provided between the rails. Take E= 2× 10^5N//mm^2 and ∝=12× 10^{-6}°C. [5marks]

Question 2

a. Describe the following terms: i. Modulus of Rigidity $\qquad$ [2marks]

                        ii. Bulk Modulus $\qquad$ [2 marks]

b. A brick pier is 700mm and 8000mm and weighs $19KN/m^3$. It is supporting an axial load from a column of 490KN. The load is uniformly spread over the top of the pier. Calculate;

i) Stress in the brickwork immediately under the column. [3 marks]

ii) Stress at the bottom of the pier. [3 marks]

c. A circular rod of diameter 16 mm and 500 mm long is subjected to a tensile force 40 KN. The modulus of elasticity for steel may be taken as $200KN/mm^2$.
. Find stress, strain and elongation of the bar due to applied load.

d. A specimen of steel 20 mm diameter with a gauge length of 200 mm is tested to destruction. It has an extension of 0.25 mm under a load of 80 KN and the load at elastic limit is 102 KN. The maximum load is 130 KN. The total extension at fracture is 56 mm and diameter at neck is 15 mm. Find;

i) The stress at elastic limit.

ii) Young's modulus.

iii) Percentage elongation.

iv) Percentage reduction in area.

v) Ultimate tensile stress.

10 marks]

Question 3

a. A steel flat of thickness 10 mm tapers uniformly from 60 mm at one end to 40 mm at other end in a length of 600 mm. If the bar is subjected to a load of 80 KN, find its extension. Take $E = 2 \times 10^5$ MPa. What is the percentage error if average area is used for calculating extension?

[12 marks]

b. A compound bar of length 600 mm consists of a strip of aluminium 40 mm wide and 20 mm thick and a strip of steel 60 mm wide × 15 mm thick rigidly joined at the ends. If elastic modulus of aluminium and steel are $1 \times 105N/mm^2$ and $2 \times 105N/mm^2$. Determine the stresses developed in each material and the extension of the compound bar when axial tensile force of 60 KN acts. [13mark]

Question 4

a) Define the following terms: i) Plastic material [2 marks]

ii) Strain [2 marks]

iii) Elastic material [2 marks]

b) A surveyor's steel tape 30 m long has a cross-section of 15 mm × 0.75 mm. With this, line AB is measure as 150 m. If the force applied during

measurement is 120 N more than the force applied at the time of calibration, what is the actual length of the line? Take modulus of elasticity for steel as $200KN/mm^2$. [6 marks]

c) i. A solid shaft, 100mm diameter, transmits 75KW at 150 revolutions per minute. Determine the value of the maximum shear stress set up in the shaft and the angle of twist per meter of the shaft length if G=80GN/ m^2. [6marks]

ii. If the shaft were now bored in order to reduce weight to produce a tube of 100mm outside diameter and 60 mm inside diameter, what torque could be carried if the same maximum shear stress is not to be exceeded? What is the percentage increase in power/ weight ratio effected by this modification?

[13marks]

Question 5

a) Define second moment of area. [1marks]

b) Describe the following properties of materials and their effect on engineering materials

i) Ductility [3 marks]

ii) Brittleness [3 marks]

iii) Malleability [3 marks]

c) A bar of uniform thickness 't' tapers uniformly from a width of b_1 at one end to b_2 at other end in a length 'L' as shown in Figure 1. Find the expression for the change in length of the bar when subjected to an axial force P. [15marks]
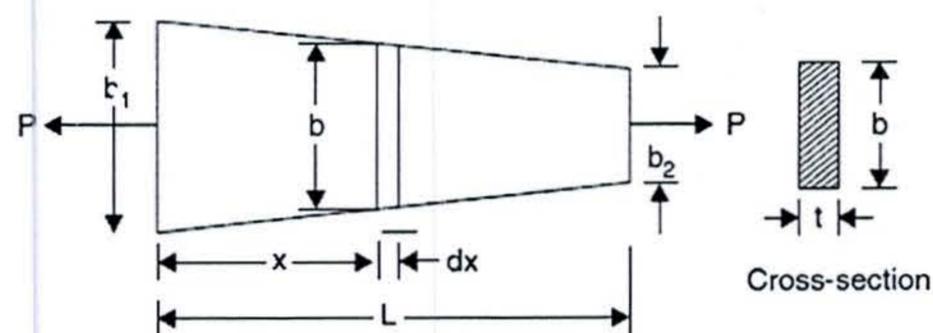

Figure1.

Question 6

a) A bar of steel 2000 mm^2 in cross-sectional area is being pulled with an axial force of 180 KN. Find the stress in the steel.   [3marks]

b) Define the term torque   [2marks]

c) A beam ABC is 9m long and supported at **B** and **C** and 6m apart as shown is figure 2 below. The beam carries a triangular distributed of load over the portion **BC** together with an applied counter clockwise couple of moment 80KN m at **B** and uniformly distributed load (UDL) of 10KN/m over **AB**, as shown in the diagram. Do the necessary computations and draw the shear force and bending moment diagrams for the beam.
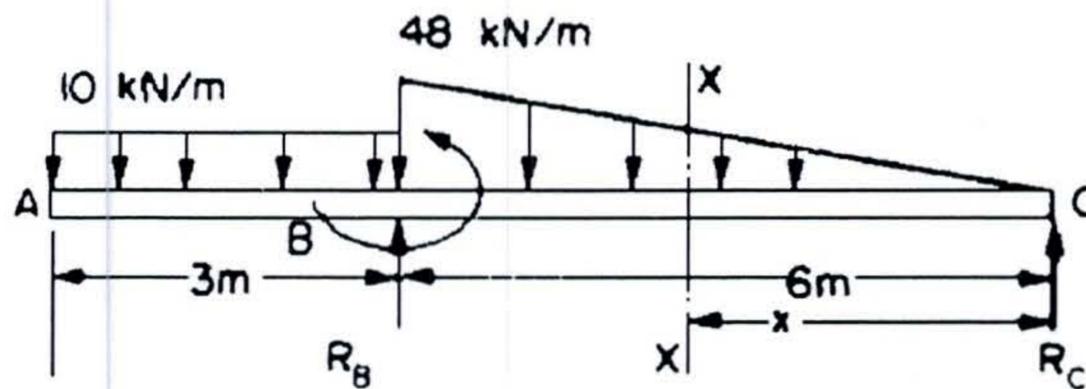
     [20marks]

Figure 2

"End of Examination Paper "