MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2024/2025 ACADEMIC YEAR

SECOND YEAR **FIRST** SEMESTER EXAMINATION FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

EMT 203 – SOLID AND STRUCTURAL MECHANICS 1

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

(a) Distinguish between stress and strain as applied in mechanics of materials. (2 marks)

(b) A hollow steel table with an internal diameter at 100 mm carries a tensile lead of 400 kN, calculate the outer diameter at the tube if the stress is limited to 120MN/m^2 (2 marks)

(c) A composite rod is 1000 mm long, its two ends are 40 mm and 30 mm in diameters and lengths are 0.3 m and 0.2 m respectively. The middle portion of the rod is 20mm in diameter and 0.5m long as shown in Fig. Q1(c). If the rod is subjected to an axial tensile load of 1000N, calculate its total elongation [E = 200GPa]. (4 marks)

(d) A tensile test was conducted on a mild steel bar. The following data in Table Q1(d) was obtained from the test. Determine the following;

i. The young's modulus (3 marks)

ii. The stress of elastic limit (2 marks)

iii. The percentage of elongation (2 marks)

iv. The percentage decrease in cross-sectional area. (2 marks)

(e) A boiler shell is to be made at 15mm which plate having a limit tensile stress of 120N/mm^2. If the efficiencies of the longitudinal and the circumferential joint are 70% and 30% respectively, determine:

i. The maximum permissible diameter at the shell for an internal pressure at 2N/mm^2 (2 marks)

ii. The permissible intensity of internal pressure when the shell diameter is 1.5m. (11 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

(a) What is the Poisson's ratio? (2 marks)

(b) A member ABCD is subjected to point loads P1, P2, P3 and P4 as shown in Fig Q2(b). Calculate.

i. The force P2 necessary for equilibrium, If P1 = 60KN, P3 = 400KN and P = 230KN. (2 marks)

ii. The total elongation of the member, assuming the modulus of elasticity to be 2.1 x 10^5N/mm^2. (6 marks)

(c) A metallic bar 250mm x 100mm x 50mm is loaded as shown in Fig. Q2(c). Determine the change that must be made in the vertical lead of 4MN such that there should be no change in the volume of the bar. Take E = 2.0 x 10^5N/mm^2 and Poisson's ratio = 0.25. (12 marks)

QUESTION THREE (20 MARKS)

(a) Define what you understand by closed–coiled helical springs. (2 marks)

(b) A closely coiled vertical spring is to carry a load of 500N. Its mean coil diameter is to be 10 times that of the wires diameter, calculate;

i. Diameter of wire

ii. Mean coil diameter

Take the maximum shear stress in the material of the spring to be 80N/mm^2. (5 marks)

(c) A steel tube of 30mm external diameter and 20mm internal diameter to which it is rigidly joined at each end. If at a temperature of 10℃ there is no longitudinal stress, calculate the stresses in the copper rod and tube when the temperature is raised to 200 ℃. Take E for the steel and copper as 2.1 x 10^5N/mm^2 and 1.0 x 10^5N/mm^2 respectively. The value of coefficient of linear expansion for steel and copper is given as 11 x 10^{-6} per ℃ and 18 x 10^{-6} per ℃ respectively. (13 marks)

QUESTION FOUR (20 MARKS)

(a) Define what you understand by terms; principle plane and principle stress. (2 marks)

(b) Distinguish between hoop and longitudinal stresses as applied to analysis of thin cylindrical shell. (2 marks)

(c) The tensile stress at a point across two mutually perpendicular planes are 120N/mm^2 and 60N/mm^2. Calculate the following stresses on a plane inclined at 30 ° to the axis of the minor stress.

i. The normal stress

ii. The tangential stress.

iii. The resultant stress (8 marks)

(d) Determine the maximum shear stress induced in a solid circular shaft of diameter 15cm when the shaft transmits 150 kW power at 180 r.p.m. (8 marks)