Total No. of printed pages = 8

END SEMESTER (REGULAR/RETEST)

EXAMINATION, MAY/JUNE-2025

Semester : 4th

Branch : Mechanical

Subject Code : Me-405

STRENGTH OF MATERIALS

Full Marks – 70

Time –Three hours

The figures in the margin indicate full marks for the questions.

Instructions :

(i) Question Nos.1, 2 and 3 are compulsory.

(ii) Answer Question Nos. 4 to 6 as per direction.

1. Fill in the blanks : 1×5=5

(a) The SI unit of shear stress is _____.

(b) The ratio of _____ to longitudinal strain is known as Poisson's ratio.

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(c) The ratio of ultimate stress and _____ is called Working stress.

(d) The point at which bending moment changes sign is called Point of _____.

(e) Euler's formula for column is applicable only for _____ column.

2. Choose the correct answers : 1×5=5

(a) The ratio of shear stress to shear strain is defined as

(i) Young's modulus

(ii) Bulk modulus

(iii) Rigidity modulus

(iv) None of the above

(b) If a metallic bar is fixed at both ends and then heated, it will develop

(i) Tensile stress

(ii) Shear stress

(iii) Compressive stress

(iv) Principal stress

(c) The bending moment at the free end of a cantilever beam is

(i) Zero

(ii) One

(iii) Maximum

(iv) None of the above

(d) The strength of a beam depends on

(i) its weight

(ii) bending moment

(iii) section modulus

(iv) None of these

(e) The strength of a column depends on which of the following factors ?

(i) slenderness ratio

(ii) end conditions

(iii) Both (i) and (ii)

(iv) None of the above

3. State True (T) or False (F) of the following statements : 1×5=5

(a) Brittle materials are weak in tension.

(b) The unit of stress is same as the unit of modulus of elasticity.

(c) Temperature stress is set up only due to rise of temperature of a bar.

(d) An overhanging beam always has point of contraflexure.

(e) Strength of a shaft means the maximum power the shaft can transmit.

4. Answer any *three* of the following questions: 3×3=9

(a) Define the following terms :

(i) Modulus of rigidity

(ii) Proof resilience

(iii) Shear Force Diagram and Bending Moment Diagram.

(b) State Hooke's law. Derive the relation of modulus of elasticity from the law.

(c) Under what conditions a beam can be said to be in pure bending ? Write at least two important assumptions of pure bending.

(d) Write the expressions for the three major strengths of a riveted joint with usual notations.

5. Answer any *four* of the following questions : 4×4=16

(a) Draw the sketch for stress versus strain diagram of common mild steel and show the significant points on it.

(b) What are the different types of loads acting on a beam ? Differentiate between a point load and a uniformly distributed load. What are the sign conventions for shear force and bending moment in general ?

(c) Define the terms :

(i) Bending stress in a beam

(ii) Neutral axis and section modulus

(iii) Strength of a section.

(d) What is 'equivalent length of a column' ? Give the ratios of equivalent length and actual length of columns with various end conditions.

(e) Define torsional rigidity of a shaft. Prove that the torsional rigidity is the torque required to produce a twist of one radian in a unit length of the shaft.

(f) Define helical springs. Name the two important types of helical springs. What is stiffness of springs ?

6. Answer any *five* of the following questions : 6×5=30

(a) A steel rod 4m long and 20 mm diameter is subjected to an axial load of 55 kN. Find the change in length, diameter and volume of the rod. Take E = 2×10^5 N/mm and Poisson's ratio = 0.25.

(b) A reinforced concrete column 300 mm × 300 mm contains 8 steel rods, each 20 mm in diameter. The column is to support a load of 360 kN. If E for steel is 15 times of E for concrete, find the load carried by steel rods and concrete.

(c) A cantilever of length 5m carries a uniformly distributed load of 2kN/m length over the whole length and a point load of 4kN at the free end. Draw the S.F. and B.M. diagrams for the cantilever.

(d) A steel plate of width 120 mm and of thickness 20 mm is bent into a circular arc of radius 10m. Determine the maximum stress induced and the bending moment which will produce the maximum stress. Take E = 2×10^5 N/mm^2.

(e) A shaft running at 140 rpm is required to transmit 37.5 kW. If the maximum torque is likely to exceed the mean torque by 25%, find the diameter of the shaft, if the maximum shear stress is 60N/mm^2. Find also the angle of twist for a length of 2.25m. Take C = 8×10^4 N/mm^2.

(f) A single riveted butt joint is provided to connect 10 mm plates with 20 mm rivets at a pitch of 80 mm. State how the joint will fail. Calculate also the efficiency of the joint. Take f_s =100 N/mm^2, f_b = 300 N/mm^2 and f_t =150 N/mm^2.

(g) A solid round bar 3 m long and 5 cm in diameter is used as a strut. Determine the crippling load if

(i) both ends of the column are hinged and

(ii) one end of the strut is fixed and the other end is free.

Take $E = 2.0 \times 10^5$ N/mm^2.