1549

April 2025

Time – Three hours

(Maximum Marks: 100)

[N.B. Answer all the questions, choosing any two subdivision from each question. Each subdivision carries 10 marks.]

1. (a) (i) Differentiate ferrous and non-ferrous materials. (3)
   (ii) Write about factors to be considered while selecting a material. (7)

   (b) (i) What is smart material? Explain any three smart materials. (7)
   (ii) Write the classification of nano material based on their structure. (3)

   (c) Explain about Brinell hardness test with a neat sketch.

   (d) Explain about shore hardness test with a neat sketch.

2. (a) A square bar of length 0.5 m and 50mm side is subjected to an axial compressive load of 100kN. Find its compressive stress, strain and final length of the bar after the application of load . Take E= 2×10^5 N/mm^2.

   (b) The ultimate stress of a hollow steel rod which carries an axial load of 2000 kN is 480 N/mm^2. If internal diameter of the rod is 137.038 mm, then find its external diameter and its thickness. Take factor of safety as 4.

   (c) Explain the procedure for conducting tensile test on mild steel using UTM with a neat diagram.

   (d) Write about the following: (i) creep test (5) (ii) fatigue test (5)

3. (a) A steel bar of 2m long, 20 mm wide and 10 mm thick is subjected to an axial compressive load of 20 kN in the direction of largest dimension of the bar. Find the final dimensions and final volume after the application of load. Take modulus of elasticity as 2×10^5 N/mm^2 and Poisson's ratio as 0.3.

   (b) A 500 mm long steel bar of circular cross section of diameter 50mm is subjected to tensile load of 100 kN. If lateral strain experienced by the bar is 0.000314, then find shear modulus and bulk modulus. Take E= 2×10^5 N/mm^2.

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(c) Calculate the strain energy that can be stored in a titanium rod of 100 mm in diameter and 10m long is subjected to a sudden tensile load of 300kN. Also find its proof resilience if load at elastic limit is 450 kN. Take E= 120 GPa.

(d) (i) Define the following: lateral strain, volumetric strain. (6)
(ii) Write the expression for strain energy stored in a bar due to axial load. (4)

4. (a) A solid shaft of length 1m and diameter 100 mm rotating at 250 rpm is connected between a turbine and generator. Find the power that shaft can transmit from turbine. Also find its polar modulus. Take shear stress as 50 N/mm^2.

(b) (i) State the assumptions made in theory of pure torsion.(5)
(ii) Write the advantages of hollow shaft over the solid shaft.(5)

(c) A hollow shaft having inner diameter 0.6 times the outer diameter is to replace a solid shaft of the same material to transmit 550kW at 220 rpm. If the permissible shear stress is 80 N/mm^2, calculate the diameters of the hollow and solid shafts. Also calculate the percentage of saving in material.

(d) Draw and explain the working principle of torsion testing machine.

5. (a) (i) Differentiate closely coiled and open coiled helical springs. (4)
(ii) Write about laminated and coiled springs. (6)

(b) A weight of 150N is dropped on to a compression spring with 10 coils made of 12mm diameter steel wire closely coiled to a diameter of 150mm. If the compression is 140 mm, calculate the height of drop. Take modulus of rigidity as 0.8×10^5 N/mm^2.

(c) A thin cylindrical shell of 1.5 m diameter and 2.5 m length is subjected to an internal pressure of 3.5 N/mm^2. If the ultimate stress experienced by the cylinder is 420 MPa, then find the minimum safest thickness of the cylinder. Also calculate the change in diameter and change in length. Take E= 2.1×10^5 N/mm^2, Poisson's ratio = 0.3 and factor of safety as 3.

(d) A closely coiled helical spring is designed to carry a load of 150kN is experiencing shear stress which is limited to 100 N/mm^2. The mean coil diameter is 15 times of wire diameter. Calculate the coil diameter and number of turns the spring has to have for supporting the given load.
