II B.Tech. II Semester Regular Examinations, April/May -2005
MECHANICS OF SOLIDS
(Common to Mechanical Engineering and Production Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. An unknown weight falls 4 cm on to a collar rigidly attached to the lower end of a vertical bar 4m long and 8 cm2 in section. If the maximum instantaneous extension is found to be 0.42 cm find the corresponding stress and the value of the unknown weight. E = 200 kN/mm^2.

2. Prove that Poissons ratio for the material of a body is 0.5, if its volume does not change when stressed. Prove also that Poisson‘s ratio is zero when there is no lateral deformation when a member is axially stressed.

3. (a) How do you classify loads? Give examples.
   (b) A simply supported beam of length 5m carries a uniformly increasing load of 800 N/m run at one end to 1600 N/m run at the other end. Draw the S.F. and B.M. diagrams for the beam.

4. (a) Find the dimensions of the strongest rectangular beam that can be cut out of a log of wood 2.6m diameter.
   (b) A T-beam having flange 160mm x 20mm and web 20mm x 170mm is simply supported over a span of 6.5m. It carries a u.d.l of 6kN/m including self weight over its entire span, together with a point load of 40kN at mid span. Find the maximum tensile and compressive stresses occurring in the beam section and sketch the stresses across the section.

5. (a) Derive the relationship between slope, deflection and radius of Curvature of a simply supported beam.
   (b) A 300 mm long cantilever of rectangular section 48 mm wide and 36 mm deep carries a uniformly distributed load. Calculate the value of load w if the maximum deflection in the cantilever is not to exceed 1.5 mm. Take $E = 70X10^9 GN/m^2$.

6. A thin cylindrical pressure vessel is made of 15C8 steel for which allowable stress at the operating temperature of 200^{o}C is 116 N/mm^2. The vessel is subjected to an internal pressure of 1.4 MPa. The cylinder has a nominal diameter of 2 m. Select a torispherical and dished closure for the vessel. Take joint factor for single piece closure equal to 1 and corrosion allowance equal to 1.5 mm.

7. Derive an expression for the major and minor principal stresses on an oblique plane, when the body is subjected to direct stresses in two mutually perpendicular directions accompanied by a shear stress.

8. (a) Derive an equation for the deflection of an open coiled helical spring.

   (b) Find the maximum permissible axial load for a closely coiled helical spring made out of 10 mm square rod with 16 coils of 12 cm mean diameter if the maximum shear stress is limited to 300 N/mm^2, calculate also the deflection under the load if N=0.84X10^5 N/mm^2.

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1. (a) Distinguish between : stress and strain, normal stress and shear stress, working stress and yield stress.
   (b) An aluminium bar 60 mm diameter when subjected to an axial tensile load 100 kN elongates 0.20 mm in a gage length 300 mm and the diameter is decreased by 0.012 mm. Calculate the modulus of elasticity and the Poisson's ratio of the material.

2. (a) State Hookes law. Draw stress-strain diagram for mild steel specimen tested under uni-axial tension till fracture and mark all the salient points.
   (b) A metallic rod of 1 cm diameter, when tested under an axial pull of 10 kN was found to reduce its diameter by 0.0003 cm. The modulus of rigidity for the rod is 51 kN/mm^2. Find the Poissons ratio, modulus of elasticity and Bulk Modulus.

3. (a) Define statically determinate and statically indeterminate beams. Give examples.
   (b) A cantilever beam of length 2m carries a uniformly distributed load of 2 kN/m over the whole length and a point load of 3 kN at the free end. Draw the SF and BM diagrams.

4. (a) Find the dimensions of the strongest rectangular beam that can be cut out of a log of wood 3.2m diameter.
   (b) A T-beam having flange 200mm x 25mm and web 25mm x 220mm is simply supported over a span of 7m. It carries u.d.l of 6.8kN/m including self weight over its entire span together with a concentrated load of 45kN at mid span. Find the maximum tensile and compressive stresses occurring in the beam section and sketch across the section.

5. (a) A beam AB of span l carries a distributed load of varying intensity from Zero at A to w per unit length at B. Measuring x from the end A, establish the equation for the deflection curve of the beam.
   (b) A 3.5 meters long cantilever carries a uniformly distributed load over the entire length. If the slope at the free end is one degree, what is the deflection at the free end.

6. A vertical steam boiler is of 2 m internal diameter and 5 m high. It is constructed with 20 mm thick plates for a working pressure of 1 N/mm^2. The end plates are flat and are not stayed.

Calculate:

(a) the stress in the circumferential plates due to resisting the bursting effect and the stress in the circumferential plate due to the pressure on the end plates

(b) the increase in length, diameter and volume. Assume the Poisson?s ratio as 0.3 and E = 200 GN/m^2.

7. (a) A body is subjected to direct stresses in two mutually perpendicular directions accompanied by a simple shear stress. Draw the Mohr‘s circle of stresses and explain how will you obtain the principal stresses and principal planes.

   (b) Draw the Mohr‘s circle for a body under pure shear and explain how will you obtain he principal stresses and principal planes.

8. An open coiled helical spring is made out of 10 mm diameter steel rod, the coils having 10 complete turns, and a mean diameter 80 mm, the angle of helix 15^0. Calculate the deflection under an axial load of 250 N and the maximum intensities of direct and shear stresses induced in the section of the wire. If the axial load of 250 N is replaced by an axial torque of 6 N.m, calculate the angle of rotation about axis of the coil and actual deflection. N=0.85X 10^5 N/mm^2 and E=2.5X$10^5 N/mm^2$.

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1. (a) Define the terms
   i. Proportional limit
   ii. Poisson's ratio
   iii. Proof stress
   iv. strain energy.
   (b) A compound bar 1 metre long is 40 mm diameter for 300 mm length, 30 mm diameter for the next 350 mm length. Determine the diameter of the remaining length so that its elongation under an axial load of 100 kN does not exceed 1mm. Take E = 2X10^5 N/mm^2.

2. (a) Derive the relationship between the three moduli of elasticity.
   (b) Show that in a prismatic bar, the maximum stress intensity due to a suddenly applied load is twice the stress intensity produced by the same load applied gradually.

3. A horizontal beam of 10m long is carrying a uniformly distributed load of 1 kN/m over the entire length. The beam is simply supported on two supports 6m apart. Find the position of the supports, so that the BM on the beam is as small as possible. Also draw the SF and BM diagrams.

4. (a) Discuss the assumptions involved in the theory of simple bending.
   (b) A cast iron beam has an I-section with top flange 100mm x 40mm, web 140mmX20mm and bottom flange 180mm x 40mm. If tensile stress is not to exceed 35MPa and compressive stress 95MPa, what is the maximum uniformly distributed load the beam can carry over a simply supported span of 6.5m if the larger flange is in tension.

5. (a) What is Macaulay's method for finding out the slope and deflection of a beam? Discuss the cases, where it is of a particular use.
   (b) A 3 meters long cantilever is loaded with a point load of 450 N at the free end. If the section is rectangular 80 mm (wide) x 160 mm (deep), and E = 10 GN/m^2, calculate slope and deflection.
   i. at the free end of the cantilever
   ii. at a distance of 0.55 m from the free end.

6. A 2.4 m internal diameter and 6 m high vertical steam boiler is constructed with 20 mm thick plates for a working pressure of 1.1 N/mm^2. The end plates are flat and are not stayed.

   Calculate

   (a) the stress in the circumferential plates due to resisting the bursting effect and the stress in the circumferential plate due to the pressure on the end plates

   (b) he increase in length, diameter and volume. Assume the Poissons ratio as 0.28 and E = 210 kN/mm^2.

7. (a) A strained material is subjected to two dimensional stresses.

      i. Prove that the sum of normal stresses on any two mutually perpendicular planes is constant.

      ii. Prove that shear stresses on any two mutually perpendicular planes are numerically equal and opposite in direction.

   (b) A steel bolt of 25mm diameter is subjected to a direct tension of 15kN and a shearing force of 10 kN. Determine the intensities of normal and shear stresses across a plane at an angle of 60^0 to the longitudinal axis of bolt. Also determine the resultant stress.

8. (a) Two shafts A and B of the same material and of the same lengths are subjected to the same torque. Shaft A is a solid circular section, while shaft B is a hollow circular section whose internal diameter is 0.7 times it's outside diameter. If the maximum shear stress in each shaft is to be the same, compare the weights of the two shafts.

   (b) A solid circular shaft 200 mm diameter has the same cross sectional area as a hollow circular shaft of the same material with inside diameter of 150 mm. For the same maximum shear stress, determine the ratio of torque transmitted by the hollow shaft to that by the solid shaft.

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1. (a) Define the terms
   i. Complementary shear
   ii. Poisson's ratio
   iii. Volumetric strain
   (b) If the Young's Modulus of elasticity of a material is twice its modulus of rigidity, then compute the Poisson's ratio of material.

2. A bar of mild steel 20 mm diameter is subjected to an axial pull of 50 kN. The increase in length over a gauge length of 200 mm is measured to be 0.16 mm. The decrease in diameter was 0.0048 mm. From the above data determine the modulus of Elasticity and Poisson's ratio of mild steel.

3. (a) Device the relations among loading, shear force and bending moment in a beam.
   (b) A cantilever beam AB span 6m is subjected to a uniformly varying load of 8kN/m intensity at the fixed end A and zero at the free end B. draw SFD and BMD.

4. (a) What is elastic section modulus?
   (b) An I section beam has 250mm wide flanges and on overall depth 550mm. Each flange is 30mm thick and the web is 25mm thick. At a certain section bending moment is M. Find what percentage of M is resisted by flanges and web.

5. (a) Explain the procedure for finding the deflection of a beam of composite section.
   (b) A cantilever 3 m long is of rectangular section 120 mm wide 240mm deep. It carries a uniformly distributed load of 2.5 kN per meter length for a length of 1.5 meters from the fixed end and a point load of 1 kN at the free end. Find the deflection at the free end. Take E = 10 GN/ m^2.

6. A 2m diameter cast iron pipe has thickness of 10 mm and is closely wound with a layer of 5 mm diameter steel wire under a tensile stress of 50 N/mm^2. If water under a pressure of 3.2 N/mm^2 is admitted into the pipe, find the stresses induced in the pipe and steel wire.

7. At a point in a strained body, planes BC and AC are perpendicular to each other. On plane BC, the normal stress is 40MPa (tensile) and shear stress is - 20MPa. On plane AC, the normal stress is - 20MPa (compressive) and shear stress is + 20MPa. Plane AB is inclined at an angle of 30^0 to the plane BC.

   Determine:

(a) the normal and shear stresses on the plane AB.

(b) The magnitude of principal stresses

(c) Principal planes with respect to plane BC

(d) maximum shear stress

(e) directions of planes carrying maximum shear stress with respect to the plane BC.

8. A solid circular shaft of diameter d has the same weight as a hollow circular shaft of mean diameter d. Assuming the same maximum shear stress in both the cases, determine the ratio of torques transmitted by the two shafts. Also compare the angles of twist per unit length in these two shafts.

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