II B.Tech. I Semester Regular Examinations, November -2005
MECHANICS OF SOLIDS
(Common to Mechatronics, Metallurgy & Material Technology and Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A bar of steel is 70 cm long. For the first 20 cm it is 2.5 cm in diameter, for the next 30 cm it is 2 cm in diameter and for the remaining 20 cm its diameter is 1.5 cm. Find the change in length of the bar if it is subjected to a tensile load of 90 kN. E = $2\times10^7 N/cm^2$. [16]

2. (a) A 38 mm diameter and 450 mm long bar extends by 20 mm when subjected to an axial tension of 100 kN. The same bar, independently, when subjected to a twisting moment of 1.27 kN-m twist through 1.922^0. Calculate the values of the four elastic constants. [10]
   (b) Show that if E is assumed correct, an error of 1% in the determination of N, involves an error of about 5% in calculating Poissons ratio when its correct value is 0.25. [6]

3. (a) Define statically determinate and statically indeterminate beams. Give examples. [6]
   (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. [10]

4. (a) A simply supported beam of span 6 m has a cross section 180 mm × 300 mm. If the permissible stress is 9 MPa, find the maximum concentrated load that can be applied at 2m from left end. [8]
   (b) A rolled steel joist of I section has top and bottom flanges 185 mm × 25 mm and web of size 300 mm × 15 mm. It is used as a simply supported beam over a span 5m to carry an uniformly distributed load of 75 kN/m over its entire span. Draw bending stress across a section at $(\frac{1}{5})$th the span. [8]

5. (a) A beam of length L is supported at each end with a couple applied at an intermediate point. Deduce an expression for the deflection and hence calculate the deflection at the point of application of the moment. [8]
   (b) A beam of length L carries a uniformly distributed load w/unit length and rests on three supports, two at the ends and one in the middle. Find how much the middle support be lower than the end ones in order that the pressures on the three supports shall be equal. [8]

6. Calculate the increase in volume enclosed by a boiler shell 2.5 m long and 1 m in diameter, when it is subjected to an internal pressure of 1.5 N/mm^2. The wall

thickness is such that the maximum tensile stress is 22 N/mm^2, under this pressure. Given E = 200 kN/mm^2 and Poisson's ratio = 0.25. [16]

7. Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the above derivation ?

[16]

8. A propeller shaft, 160mm external diameter, 80mm internal diameter, transmits 450kW at 4/3 Hz. There is, at the same time, a bending moment of 30kN-m and an end thrust of 250kN. Find

   (a) the maximum principal stresses and their planes [6]

   (b) the maximum shear stress and its plane [6]

   (c) the stress, which acting alone, will produce the same maximum strain. Take poisson's ratio = 0.3 [4]

⋆ ⋆ ⋆ ⋆ ⋆

II B.Tech. I Semester Regular Examinations, November -2005
MECHANICS OF SOLIDS
(Common to Mechatronics, Metallurgy & Material Technology and Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Define and explain the terms: [6]
   i. Modulus of Elasticity
   ii. Modulus of Rigidity
   iii. Poisson's ratio
   iv. Bulk Modulus.
   (b) Two vertical rods one of steel and the other of copper are each rigidly fixed at the top and 600 mm apart. The diameter and length of each rod are 30 mm and 375 mm respectively. A cross bar fixed to the rods at the lower ends carries a load of 5 kN such that the cross bar remains horizontal even after loading. Find the stress in each rod and the position of the load on the bar. E_S = 200 Gpa and E_C = 100 Gpa. [10]

2. A steel rod 28 mm diameter is fixed concentrically in a brass tube of 42 mm outer diameter and 30 mm inner diameter. Both the rod and tube are 450 mm long. The compound rod is held between two stops which are exactly 450 mm apart and the temperature of the bar is raised by 70^0C. [16]
   (a) Find the stresses in the rod and tube if the distance between the stops is increased by 0.30 mm.
   (b) Find the increase in the distance between the stops if the force exerted between them is 90 kN

   Take $E_S = 200 kN/mm^2$; $\alpha_S = 11.2 \times 10^{-6} per^0$C
   $E_b = 90 kN/mm^2$; $\alpha_b = 2.1 \times 10^{-5} per^0$C

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. [16]

4. (a) Obtain from first principles the expression for shear stress at any point in a circular section of a beam where it is subjected to a shear force F. Sketch the stress variation. [8]
   (b) An I-section has the following dimensions.
   Top and bottom flanges = 165 mm × 20 mm
   Web = 15 mm thick and 200mm deep

The maximum shear stress developed in the beam is 17MPa.
Find the shear force to which the beam is subjected. [8]

5. (a) Explain the procedure for finding the deflection of a beam of composite section. [6]

   (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 . [10]

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. [8]

   (b) the increase in length, diameter and volume. [8]

   Assume the Poisson's ratio as 0.28 and E = 210 kN/mm^2.

7. Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the above derivation ? [16]

8. A propeller shaft, 160mm external diameter, 80mm internal diameter, transmits 450kW at 4/3 Hz. There is, at the same time, a bending moment of 30kN-m and an end thrust of 250kN. Find

   (a) the maximum principal stresses and their planes [6]

   (b) the maximum shear stress and its plane [6]

   (c) the stress, which acting alone, will produce the same maximum strain. Take poisson's ratio = 0.3 [4]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR211402 **Set No.3**

II B.Tech. I Semester Regular Examinations, November -2005
MECHANICS OF SOLIDS
(Common to Mechatronics, Metallurgy & Material Technology and Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Define the terms: [6]
   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. [10]

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. [16]

3. Sketch the shear force and bending moment diagrams showing the salient values for the loaded beam shown in the figure 1 below. [16]

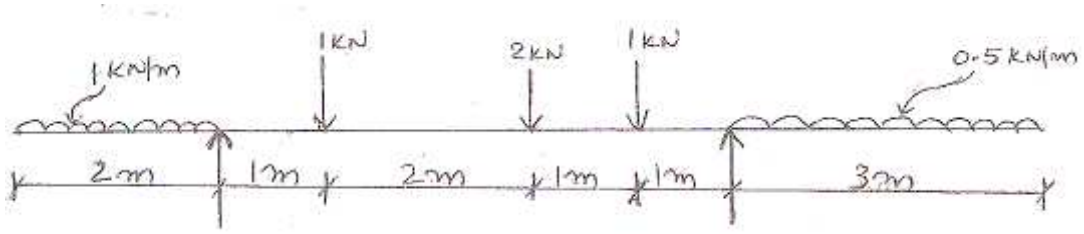

Figure 1:

4. (a) What is elastic section modulus? [4]
   (b) A beam resting freely on supports 5.8m apart carries a u.d.l of 12 kN/m and also a point load of 15 kN at 2m from the left support. If the permissible stress in timber is 5 MPa, design a suitable section by making the depth equal to 1.8 times the width. [12]

5. (a) What is moment area method? Explain the two Mohr's theorems, as applicable to the slope and deflection of a beam. [6]
   (b) A cantilever of uniform cross-section of length l carries two point loads, W at the free end and 2W at a distance a from the free end. Find the maximum deflection due to this loading. [10]

6. The cylindrical shell made of steel is having a diameter of 3 m and the shell is subjected to an internal pressure of 1.5 N/mm^2. Longitudinal joint efficiency of the shell is 85%, ultimate tensile strength of the steel plate is 480 N/mm^2 and the factor of safety is 5. Determine the thickness of the shell plate. [16]

7. (a) Derive an expression for the stresses on an oblique section of a rectangular body, when it is subjected to direct stresses in two mutually perpendicular directions. [8]

   (b) A piece of material is subjected to a tensile stress of 60 N/mm^2 and 30 N/mm^2 at right angles to each other. Find fully the stresses on a plane the normal of which makes an angle of 40^0 with the 60 N/mm^2 stress. [8]

8. (a) Determine the crippling load for a T-Section of dimensions 10cm $\times 10cm \times$ 2cm and of length 5m when it is used as a long column with [10]

   i. both of its ends hinged and

   ii. both of its ends fixed.

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

   (b) State the assumptions made in Euler's column theory. [6]

⋆ ⋆ ⋆ ⋆ ⋆

II B.Tech. I Semester Regular Examinations, November -2005
MECHANICS OF SOLIDS
(Common to Mechatronics, Metallurgy & Material Technology and Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Define and explain the terms: [6]
   i. Modulus of Elasticity
   ii. Modulus of Rigidity
   iii. Poisson's ratio
   iv. Bulk Modulus.
   (b) Two vertical rods one of steel and the other of copper are each rigidly fixed at the top and 600 mm apart. The diameter and length of each rod are 30 mm and 375 mm respectively. A cross bar fixed to the rods at the lower ends carries a load of 5 kN such that the cross bar remains horizontal even after loading. Find the stress in each rod and the position of the load on the bar. E_S = 200 Gpa and E_C = 100 Gpa. [10]

2. Prove that Poisson's 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. [16]

3. A overhanging beam of span 10m is supported at two points, one at the left end and the other at 8m apart. It has a uniformly varying load of 3 kN/m run at the left extreme to zero at the right extreme. Draw the SF and BM diagrams. [16]

4. (a) State the assumptions involved in the theory of simple bending. [6]
   (b) Derive the Bending equation from fist principle. [10]

5. (a) A beam of length L is supported at each end with a couple applied at an intermediate point. Deduce an expression for the deflection and hence calculate the deflection at the point of application of the moment. [8]
   (b) A beam of length L carries a uniformly distributed load w/unit length and rests on three supports, two at the ends and one in the middle. Find how much the middle support be lower than the end ones in order that the pressures on the three supports shall be equal. [8]

6. (a) Explain why 'wire wound their cylinders' are more efficient than 'ordinary thin cylinders'. [6]
   (b) A seamless pipe of 1m diameter is carrying a fluid under a pressure of 10 N/mm^2. Calculate the necessary thickness of the pipe, if the maximum allowable stress in the pipe material is 100 N/mm^2. [10]

7. (a) Write the significance of Mohr's circle and it's uses. [6]

   (b) At a point in a beam section, there is a longitudinal bending stress of 120 N/mm^2 tensile and a transverse shear stress of 50 N/mm^2. Find the resultant stress on a plane inclined at 30^0 to the longitudinal axis. [10]

8. A helical spring consists of 10 coils of mean coil diameter 200mm and helix angle 30^0. It is made out of 10mm diameter steel rod. If the spring is subjected to an axial couple of 15N-m, calculate

   (a) the axial deflection and angular rotation of one end of the spring with respect to the other, [8]

   (b) the maximum principal and shear stresses in the spring material. Take E = 200Gpa and G = 80Gpa. [8]

⋆ ⋆ ⋆ ⋆ ⋆