19CET203-Mechanics of Solids

UNIT – 1

2 MARKS

1) What is the principle of Super position? Explain its uses.
2) Define stress and strain. What are the different types of stresses and strains? Define the terms: Elasticity, Elastic limit, Young's Modulus and Modulus of rigidity.
3) State Hooke's Law?
4) Find the Young's Modulus of a brass rod of diameter 50mm and of length 550mm which is subjected to a tensile load of 70 kN when the extension of the rod is equal to 0.9mm.
5) Write the relationship between bulk modulus, rigidity modulus and Poisson's ratio.
6) Explain the significance of Mohr's circle and its uses
7) State the relationship between Young's Modulus and Modulus of Rigidity.
8) Draw stress – strain diagram for mild steel, brittle material and a ductile material and indicate salient points.
9) What are principal planes?
10) Define the term 'obliquity' and how it is determined.

13 MARKS

1) A tensile test was conducted on a mild steel bar.

   The following data was obtained from the test:

   Diameter of the steel bar = 9 cm

   Gauge length of the bar = 28 cm

   Load at elastic limit = 450 kN

   Extension at a load of 350 kN = 0.71 mm

   Maximum load = 400 kN

   Total extension = 90 mm

   Diameter of rod at failure = 2.95 cm

   Determine: a) The Young's modulus b) The stress at elastic limit c) The percentage of elongation d) The percentage decrease in area.

2) A steel tube 50mm external diameter 5mm thick encloses centrally a copper bar of 30 mm diameter. The bar and tube are rigidly connected together at the end at a temperature of 30°C. The composite bar is subjected to an axial compressive load of 60kN and the temperature is raised to 150°C. Determine the stresses in the steel tube and copper rod $\alpha s = 12x10^{-6}$ / °C, $\alpha cu = 18x10^{-6}$ / °C, Es = 200 GPa, Ecu = 100 GPa.

3) The normal stresses acting on two perpendicular planes at a point in a strained material are 100 MN/ m^2 tensile, 45 MN/ m^2 compressive. In addition, shear stress of 50 N/mm2 act on these planes. Calculate the following: (i)The magnitude of the principal stresses (ii)The direction of the principal planes (iii)The magnitude of the maximum shear stress.

4) Three bars made of copper, zinc and Aluminium are of equal length and have cross section 650, 950 and 1900sq.mm respectively. They are rigidly connected at their ends. If this compound member is subjected to a longitudinal pull of 550kN, Estimate the proportion of the load carried on each rod and the induced stresses. Take the value of E for Copper = 1.3×10^5 N/mm^2, for Zinc = 1×10^5 N/mm^2 and for Aluminium = 0.8×10^5 N/mm^2.

5) A rod is 4m long at a temperature of 50°C. Find the expansion of the rod, when the temperature is raised to 70°C. If the expansion is prevented, find the stress induced in the material of the rod. Take E=$1.0X10^5$ MN/m^2 and α=0.000012 per degree centigrade.

6) A solid circular bar of diameter 20mm when subjected to an axial tensile load of 40 KN, the reduction in diameter of the rod was observed as $6.4x10^{-3}$ mm. The bulk modulus of the material of the bar is 67 GPa. Determine the following. a)Young modulus, b) Poisson's ratio, c) Modulus of rigidity, d) Change in length per meter and e) Change in volume of the bar per meter length

7) The Ultimate stress for a hollow steel Column which carries an axial load of 4.9 MN is 780 N/mm^2. If the external Diameter of the column is 400mm, Determine the internal Diameter. Take the Factor of Safety as 4.

8) Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30mm and of length 1.5m if the longitudinal strain in a bar during a tensile stress is 4 times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of 100 N/mm^2. Take E = $1x10^5$ N/mm^2**.**

UNIT – 2

2 MARKS

1) Define beam and point of contra flexure.
2) Define and explain the following terms: Shear force, bending moment, Shear force diagram & bending moment diagram.
3) Classify the types of beams with neat sketch.
4) Explain Simple Bending Equation and the Assumptions made in the theory of simple Bending?
5) Sketch any 2 types of supports used for a beam indicating the reactions in each case.
6) A cantilever beam of span 4m is subjected to a UDL of 2 kN/m over its entire length. Sketch the bending moment diagram for the beam
7) State the theory of simple bending and also assumptions made in the theory on bending?
8) Draw the S.F. & B.M. diagrams for simply supported beam of length L carrying a point load W at its middle point.
9) What do you mean by section modulus? Find an expression for section modulus for rectangular, circular & hollow circular sections.
10) A beam subjected to a bending stress of $5 N/mm^2$ and the section modulus is $3530 cm^3$ What is the moment of resistance of the beam?

13 MARKS

1) A cantilever of length 4m carries a of 3KN/m run over the whole length and two-point loads of 4KN and 2.5KN are place 1m and 2m respectively from the fixed end. Draw the shear force and BM diagram
2) Explain the theory of Simple bending and the Assumptions made. Derive the Expression for Bending stress
3) A beam 6m long and simply supported at each end has a uniformly distributed load of 800 N/m extending from the left end to a point 2 m away. There is also a clockwise couple of 1500 Nm. applied at the centre of the beam AB. Draw the shear force and bending moment diagrams for the beam and find the maximum bending moment.
4) A rectangular beam of width 100 mm and depth 200 mm is simply supported over a span of 6 m and carries a central concentrated load of 20 kN. Determine the maximum bending and shear stress in the beam and indicate where in the beam they occur. Plot the distribution of the stresses across the depth at any cross section.

5) A Cantilever 1.5m long is loaded with a uniformly distributed load of 2 kN /m run over a length of 1.25m from the free end. It also carries a point load of 3 kN at a distance of 0.25m from the free end. Draw the shear force and Bending moment diagrams of the Cantilever.
6) Draw a shear force and Bending moment diagrams for a simply supported beam of length 9m and carrying a Uniformly distributed load of 10 kN/m for a distance of 6m from the left end.

UNIT – 3

2 MARKS

1) What are the methods for finding out the slope and deflection at a section?
2) What is the slope at the support for a simply supported beam of length L, constant EI and carrying central concentrated load?
3) What is meant by determinate and indeterminate beams?
4) Write the relation between deflection of bending moment and flexural rigidity for a beam?
5) why moment method is more useful when compared with double integration?
6) What is a shear centre?
7) A cantilever beam of span 'L' is subjected to a concentrated load 'w' at free end. What would be the maximum slope and deflection?
8) When Macaulay's method is preferred?
9) What is meant by deflection of beams?
10) What are the values of slope and deflection for a cantilever beam of length 'L' subjected to Moment 'M' at the free end?

13 MARKS

1. A beam of length 6m is simply supported at its ends and carries two-point loads of 48 kN and 40 kN at a distance of 1m and 3m respectively from the left support. Find

i) Deflection under each load

ii) Maximum Deflection

iii) The point at which maximum deflection occurs

Given E = 2×10^5 N/mm^2 and I = 85×10^6 mm^4. Use Macaulay's Method.

2) A cantilever of length 2.5m is loaded with an UDL of 10 kN/m over a length 1.5m from the fixed end. Determine the slope and deflection at the free end. Determine the slope and deflection at the free end of the cantilever L = $9500cm^4$, E = 210 GN / m^2 using Moment area method.

3) A Simply Supported beam 5m long carries concentrated loads of 10 kN each at points 1m from the ends. Calculate

i) Maximum slope and deflection of the beam and

ii) Slope and Deflection under each load

Take EI = $1.2X10^4$ kN /m^2

4) A simply supported beam of span 3 m is subjected to a central load of 10 kN. Find the maximum slope and deflection of the beam. Take I = 12×10^6 mm^4 and E = 200 GPa.

5) A beam AB of span 6m is simply supported at its ends is subjected to a point load of 20kN at C at a distance of 2m from left end. Compute the deflection at the point C, slope at the points A, B and C. Take I = 6 $x10^8$ mm^4 and E = 200GPa. Use Macaulay's Method.

UNIT – 4

2 MARKS

1) Write down the expression for power transmitted by a shaft
2) Define torsional rigidity
3) Define Springs? What are the various types of springs?
4) Classify the helical springs.
5) What is spring index (C)?
6) Write the assumptions in the theory of pure torsion.
7) In a Hollow circular shaft of outer and inner diameters of 50cm and 60cm respectively, the shear stress is not to exceed $80N/mm^2$. Find the maximum torque which the shaft can safely transmit.
8) Define Torsion
9) Why hollow circular shafts are preferred when compared to solid circular shafts?
10) Write down the expression for torque transmitted by hollow shaft

13 MARKS

1) A hollow shaft having an internal diameter 30% of its external diameter, transmits 552.5 kW power at 100 r.p.m. Determine the external diameter of the shaft if the shear stress is not to exceed 70 N /mm^2 and the twist in a length of 3.5m should not exceed 1.4

degrees. Assume maximum torque = 1.25 mean torque and the modulus of rigidity = $9x10^4$ N/mm^2.

2) The Stiffness of a close-coiled helical spring is 1.5 N/mm of compression under a maximum load of 80N. The maximum shearing stress produced in the wire of Spring is 135 N/mm^2. The solid length of the spring (when the coils are touching) is given as 6 cm. Find

i) Diameter of Wire

ii) Mean diameter of the coils

iii) Number of coils required

Take C = 4.5 $x10^4$ N/mm^2.

3) A solid circular shaft transmits 75kW power at 200 rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed one degree in 2m length of shaft and shear stress is not exceed 50 N/mm^2. Assume the modulus of rigidity of the material of the shaft as 100 kN/mm^2.

4) A close coiled helical spring has a stiffness of 5N/mm. its length when fully compressed with adjacent coils touching each other is 40 cm. the modulus of rigidity of the material of the spring is $8x10^4$ N/mm^2. Determine the wire diameter and mean coil diameter if their ratio is 1/10. What is the corresponding maximum shear stress in the spring?

5) Derive the torsion equation for a circular shaft of diameter 'd' subjected to torque 'T. Find the torque that can be transmitted by a thin tube 6 cm mean diameter and wall thickness 1 mm. the permissible shear stress is 6000 N/cm^2

6) In a tensile test a test piece of 25mm diameter, 200 mm gauge length, stretched 0.0975mm under a pull of 60 kN. In a torsion test, the same rod twisted 0.025 radian over a length of 250mm when a torque of 0.5 kNm was applied. Evaluate Poisson's ratio and three elastic moduli for the material.

UNIT – 5

2 MARKS

1) Differentiate thin cylinder & thick cylinder
2) Justify why wire winding is done in thin cylinder?
3) Write the expression for longitudinal strain and circumferential strain in the case of thin cylindrical shells.
4) Name the stress develops in the cylinder.
5) Describe the lame's theorem.
6) Define-hoop stress & longitudinal stress.
7) State the assumption made in lame's theorem for thick cylinder analysis
8) A storage tank of internal diameter 280 mm is subjected to an internal pressure of 2.56 MPa. Find the thickness of the tank. If the hoop & longitudinal stress are 75 MPa and 45 MPa respectively
9) Distinguish between cylinder shell and spherical shell.
10) How does a thin cylinder fail due to internal fluid pressure?

13 MARKS

1) A cylindrical vessel, whose ends are closed by means of rigid flange plates, is made up of steel plate 3mm thick. The length and internal diameter of the vessel are 60cm and 30cm respectively. Determine the longitudinal and hoop stresses in the cylindrical shell due to an internal fluid pressure of 4 N/mm^2. Also calculate the increase in length, diameter and volume of vessel. Take $E = 2\times10^5$ N/mm^2 and μ =0.3.
2) A cylindrical thin drum 80cm in diameter and 3m long has a shell thickness of 1cm. If the drum is subjected to an internal pressure of 2.5 N/mm^2, Determine (i) Change in diameter (ii) Change in length and (iii) Change in volume $E=2\times10^5$N/mm2 and Poisson's ratio=0.25
3) A copper cylinder, 90 cm long, 40 cm external diameter and wall thickness 6mm had its both ends closed by rigid blank flames. It is initially full of oil at atmospheric pressure calculate the additional volume of all which must be pumped into it in order to rise the oil pressure to 5 N/mm^2 above atmospheric pressure. For copper assume $E = 1.0 \times 10^6$ N/mm^2 and Poisson's ratio = 1/3. Take bulk modulus of oil is 2.6×10^8 N/mm^2.

4) A spherical shell of internal diameter 0.9m and of thickness 10mm is subjected to an internal pressure of 1.4N/mm^2. Determine the increase in diameter and increase in volume. E=2×10^5N/mm2 and Poisson's ratio=1/3.

5) A cylindrical shell 3m long which is closed at the ends has an internal diameter of 1.5m and a wall thickness of 20mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the steel. If it is subjected to an internal pressure of 1.5 N/mm^2 Take E=2×10^5N/mm^2 and Poisson's ratio=0.3.