INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**STRENGTH OF MATERIALS - I**
Course Code	:	**A30107**
Class	:	II B. Tech I Semester
Branch	:	CE
Year	:	2016 – 2017
Course Coordinator	:	Dr. Akshay S. K. Naidu, Professor, Department of CE
Course Faculty	:	Dr. Akshay S. K. Naidu, Professor, Department of CE

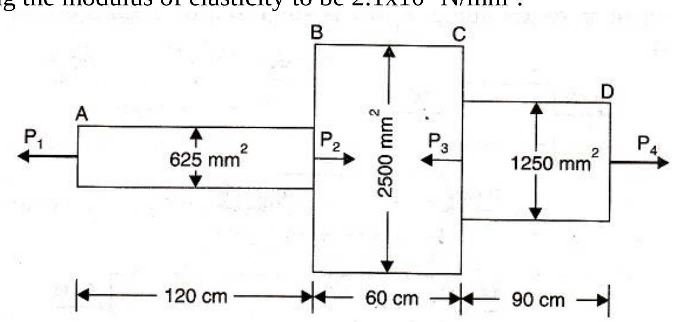
OBJECTIVES

The objectives of this course are to impart knowledge and abilities to the students to:

I. **Relate** mechanical properties of a material with its behaviour under various load types
II. **Classify** the types of material according to the modes of failure and stress-strain curves.
III. **Apply** the concepts of mechanics to find the stresses at a point in a material of a structural member
IV. **Analyze** a loaded structural member for deflections and failure strength
V. **Evaluate** the stresses & strains in materials and deflections in beam members
VI. **Create** diagrams for shear force, bending moment, stress distribution, mohr's circle, elastic curve
VII. **Design** simple beam members of different cross-sections to withstand the loads imposed on them.

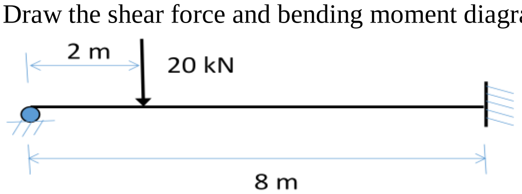
S No	QUESTION	Blooms taxonomy level	Course Outcomes
	UNIT - I SIMPLE STRESSES AND STRAINS, STRAIN ENERGY		
	Part - A (Short Answer Questions)		
1	Distinguish between the terms (a) Elasticity and (b) Plasticity with examples.	Remembering	1
2	Define the following properties of engineering materials: (a) Ductility (b) Brittleness (c) Malleability	Remembering	1
3	Define the following properties of engineering materials: (a) Toughness (b) Hardness (c) Strength	Remembering	1
4	Define Stress at a point in a material, and mention its units.	Remembering	1
5	Distinguish between different types of stress using illustrations	Remembering	1
6	Define Strain in a material and give its units	Remembering	1
7	State Hooke's law and give its equation	Remembering	1
8	Distinguish between different types of strain	Remembering	1
9	Define modulus of elasticity and give its units.	Remembering	1
10	Draw stress-strain diagram for mild steel indicating all critical points	Understanding	1
11	Define longitudinal strain and lateral strain.	Remembering	1
12	Define Poisson's ratio and its range of values	Remembering	1

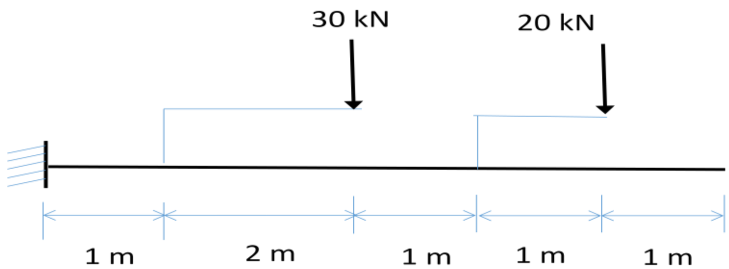
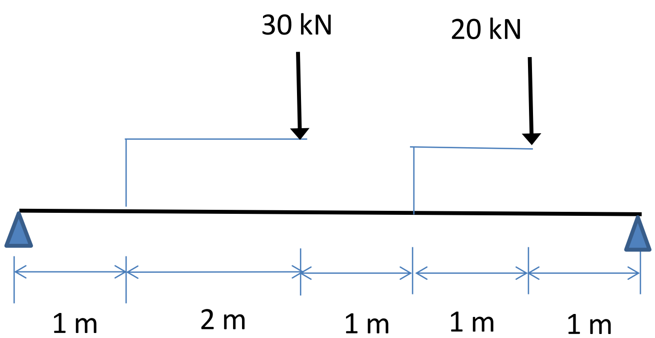
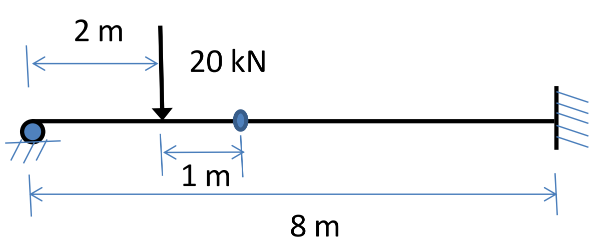
13	Define Volumetric strain and bulk modulus	Remembering	1
14	Give the relationship between Young's modulus, Rigidity Modulus and Bulk Modulus.	Remembering	1
15	Define rigidity modulus and give its units	Remembering	1
16	What is meant by strain energy?	Understanding	1
17	Distinguish between modulus of resilience and modulus of toughness.	Understanding	1
18	Define resilience and proof resilience.	Understanding	1
19	What is working stress?	Understanding	1
20	Define factor of safety and state why it is used?	Understanding	1
Part - B (Long Answer Questions)			
1	Explain with illustrations and stress-strain diagrams, the phenomenon of strain-hardening.	Understanding	1
2	Explain with illustrations and stress-strain diagrams, the phenomenon of necking.	Understanding	1
3	Define and explain the terms: slip and creep.	Understanding	1
4	Explain the off-set method of locating the yield point for a material on its stress-strain curve.	Understanding	1
5	Explain the concept of fatigue failure. Define endurance limit and fatigue limit.	Understanding	1
6	A tensile test was conducted on a mild steel bar. The following data was obtained from the test: Diameter of steel bar = 2.5 cm; Gauge length of the bar = 24 cm; Diameter of the bar at rupture = 2.35 cm; Gauge length at rupture = 24.92mm Determine (a) percentage elongation (b) percentage decrease in area	Applying	1,2
7	A tensile test was conducted on a mild steel bar. The following data was obtained from the test: Diameter of steel bar = 3cm; Gauge length of the bar = 20cm Load at elastic limit = 250kN; Extension at load of 150kN = 0.21mm Maximum load = 380kN; Determine: (a) Young's modulus (b) Yield strength (c) Ultimate Strength (d) Strain at the elastic limit	Applying	1,2
8	A steel bar of 25 mm diameter is tested in tension and following is observed: Limit of Proportionality = 196.32 kN; Load at yield = 218.13 kN, Ultimate load = 278.20 kN. Compute the stresses in the specimen at various stages. If the factor of safety is 1.85, determine the permissible stress in the material.	Applying	1,2
9	A steel bar of 25 mm diameter was tested in tension and following were observed: Limit of Proportionality = 196.32 kN; Load at yield = 218.13 kN, Ultimate load = 278.20 kN. At the proportional limit, the elongation measured over a gauge length of 100 mm was 0.189 mm. After fracture, the length between the gauge points was 112.62 mm and the minimum diameter was 23.64. Determine the Young's modulus and measures of ductility (percentage elongation and percentage contraction),	Applying	1,2
10	A 3.5 m long steel column of cross-sectional area 5000 mm^2, is subjected to a load of 1.6 MN. Determine the factor of safety for the column, if the yield stress of steel is 550 MPa. Determine the allowable load on the column, if the deformation of the column should not exceed 5.0 mm. Assume Young's modulus of steel as 195 GPa.	Applying	1,2
11	A 2.0 m long steel tie bar is subjected to force of 150 kN. Determine its cross-section so that (i) the stress does not exceed 140 MPa (ii) the extension is not more than 1.2 mm. Assume Young's modulus of 210 GPa. If steel bars are available in increments of 5 mm from 30 mm diameter onwards, choose the appropriate diameter for both cases.	Applying	1,2

<table>
<tr><td>12</td><td>Design a steel rod to sustain a load of 80 kN with a safety factor 2.5. What is the maximum permissible length of the rod, if the allowable deformation is 0.5 mm? Assume a yield stress of 230 MPa and Young's modulus of 195 GPa.</td><td>Applying</td><td>1,2</td></tr>
<tr><td>13</td><td>Derive the constitutive relationship between stress and strain for three dimensional stress systems.</td><td>Applying</td><td>1,2</td></tr>
<tr><td>14</td><td>A rod whose ends are fixed to rigid supports, is heated so that rise in temperature is T^o C. Derive the expression for thermal strain and thermal stresses set up in the body if α is co-efficient of thermal expansion.</td><td>Applying</td><td>1,2</td></tr>
<tr><td>15</td><td>Derive the expression for volumetric strain of a body in terms of its linear strains in orthogonal directions.</td><td>Applying</td><td>1,2</td></tr>
<tr><td>16</td><td>Derive relationships between Young's modulus, rigidity modulus and bulk modulus, including Poisson's ratio into the relationships.</td><td>Applying</td><td>1,2</td></tr>
<tr><td>17</td><td>Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is $1.2\text{x}10^5$ N/mm^2 and modulus of rigidity is $4.5\text{x}10^4$ N/mm^2</td><td>Applying</td><td>1,2</td></tr>
<tr><td>18</td><td>Prove that maximum strain energy stored per unit volume in a body is given by
$$U = \left(\frac{\sigma^2}{2E}\right)$$</td><td>Applying</td><td>1,2</td></tr>
<tr><td>19</td><td>If the extension produced in a rod due to impact load is very small in comparison with the height through which the load falls, prove that stress induced in the body is given by
$$\sigma = \sqrt{\frac{2EPh}{A.L}}$$</td><td>Applying</td><td>1,2</td></tr>
<tr><td>20</td><td>Prove that the stress developed in a body due to load P when it is applied suddenly is given by
$$\sigma = 2\frac{P}{A}$$</td><td>Applying</td><td>1,2</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Part - C (Problem Solving and Critical Thinking Questions)</td></tr>
<tr><td>1</td><td>A tensile test was conducted on a mild steel bar. The following data was obtained from the test:
Diameter of steel bar = 3 cm
Gauge length of the bar = 20 cm
Load at elastic limit = 250 kN
Extension at load of 150 kN = 0.21 mm
Maximum load = 380 kN
Total extension = 60 mm
Diameter of rod at failure = 2.25 cm
Determine: (a) Young's modulus (b) stress at elastic limit (c) percentage elongation (d) percentage decrease in area</td><td>Analyze & evaluate</td><td>1,2,3</td></tr>
<tr><td>2</td><td>A member ABCD is subjected to point loads P1, P2, P3 and P4 as shown in figure below. Calculate the force P2 necessary for equilibrium, if P1 = 45kN, P2 = 450kN and P4 = 130kN. Determine the total elongation of the member, assuming the modulus of elasticity to be $2.1\text{x}10^5$ N/mm^2.

</td><td>Analyze & evaluate</td><td>1,2,3</td></tr>
</table>

3	A compound tube consists of a steel tube 140mm internal diameter and 160mm external diameter and an outer brass tube 160mm internal diameter and 180mm external diameter. The two tubes are of the same length. The compound tube carries an axial load of 900kN. Find the stresses and the load carried by each tube and the amount it shortens. Length of each tube is 140mm. Take E for steel as $2x10^5$ N/mm^2 and for brass as $1x10^5$ N/mm^2.	Analyze & evaluate	1,2,3
4	A steel rod of 3cm diameter and 5m long is connected to two grips and the rod is maintained at a temperature of 95^oC. Determine the stress and pull exerted when the temperature falls to 30^oC, if (i) the ends do not yield, and (ii) the ends yield by 0.12cm. Take E = $2x10^5$ MN/m^2 and $\alpha = 12x10^{-6}/^oC$.	Analyze & evaluate	1,2,3
5	Determine the value of Young's modulus and Poisson's ratio of a metallic bar of length 25cm, breadth 3cm and depth 2cm when the bar is subjected to an axial compressive load of 240kN. The decrease in length is given as 0.05cm and increase in breadth is 0.002cm.	Analyze & evaluate	1,2,3
6	A metallic block 250mm x 80mm x 30mm is subjected to a tensile force of 20kN, 30kN and 15kN along x, y and z directions respectively. Determine the change in volume of the block. Take E= $2x10^5$ N/mm^2 and Poisson's ratio = 0.30.	Analyze & evaluate	1,2,3
7	Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is $1.2x10^5$ N/mm^2 and modulus of rigidity is $4.5x10^4$ N/mm^2	Analyze & evaluate	1,2,3
8	A bar of 30mm in diameter was subjected to tensile load of 54kN and the measured extension on 300mm gauge length was 0.112mm and change in diameter was 0.0036mm. Calculate the Poisson's ratio and three Modulii.	Analyze & evaluate	1,2,3
9	A bar of uniform cross-section 'A' and length 'L' hangs vertically, subjected to its own weight. Prove that the strain energy stored within the bar is given by $$U = \frac{A \times \rho^2 \times L^3}{6E}$$	Analyze & evaluate	1,2,3
10	A vertical round steel rod 1.82m long is securely held at its upper end. A weight can slide freely on the rod and its fall is arrested by a stop provided at the lower end of the rod. When the weight falls from a height of 30mm above the stop, the maximum stress reached in the rod is estimated to be $157N/mm^2$. Determine the stress if the load has been applied gradually and also the maximum stress if the load had fallen from a height of 47.5mm. Take E = $2.1x10^5$ N/mm^2.	Analyze & evaluate	1,2,3
11	A bar of length *l* has its diameter increasing from *d* at one end to D at the other. Determine the deformation of the member subjected to a tensile force of P.	Analyze & evaluate	1,2,3
12	A prismatic bar of length l and unit weight w is suspended freely from its end. Determine the elongation of the member under gravity.	Analyze & evaluate	1,2,3
13	A concrete column is reinforced with steel bars comprising 6 percent of the gross area of the column section. What is the fraction of the compressive load sustained by steel bars, if the ratio of Young's modulii of steel and concrete is 12.5?	Analyze & evaluate	1,2,3
14	A steel rod of uniform square cross-section with side 22.0 mm and length 500.00 mm is rigidly held between its end by fixed supports. Assuming α = 12.5 x 10^{-6} per K and E = 150.0 GPa, determine the force and the stress in the rod when it is subjected to (i) rise in temperature of 85 K and (ii) fall in temperature of 65 K?	Analyze & evaluate	1,2,3
15	A steel rod of tapered square cross-section with larger side 40 mm and smaller side 20 mm and length 650 mm is rigidly held between its end by fixed supports. Assuming α = 12.5 x 10^{-6} per K and E = 150.0 GPa, determine the force in the rod when it is subjected to (i) rise in temperature of 85 K and (ii) fall in temperature of 65 K?	Analyze & evaluate	1,2,3
16	A steel rod of tapered circular cross-section with larger end diameter 65 mm and smaller end diameter 33 mm and length 810 mm is rigidly held between its end by fixed supports. Assuming α = 12.5 x 10^{-6} per K and E = 150.0 GPa, determine the force in the rod when it is subjected to (i) rise in temperature of 85 K and (ii) fall in temperature of 65 K?	Analyze & evaluate	1,2,3

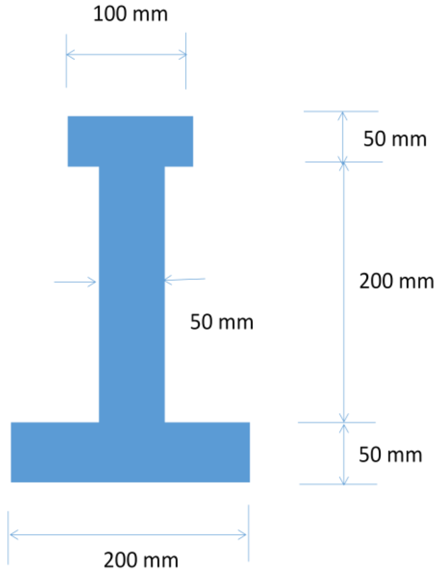
17	A compound bar comprises of a 12.5 mm diameter aluminum rod and a copper tube of inner diameter 14.5 mm and outer diameter 25 mm. If the Young'd modulli of aluminum and copper are 80 GPa and 120 GPa, respectively, then determine the stress in the assembly when subjected to (i) a temperature rise of 95 K, and (ii) a temperature fall of 35 K. Take α = 14.6 x 10^{-6} per K for aluminum and α = 16.8 x 10^{-6} per K for copper.	Analyze & evaluate	1,2,3
18	Determine the resilience and toughness modulii of mild steel (E = 200 GPa) with a yield stress of 250 MPa and fracture strain of 28.5 percent. Neglect strain hardening effects. From these data determine the impact resistance of a bar of 12 mm diameter and 500 mm length.	Analyze & evaluate	1,2,3
19	A mass of 250 kg falls through a height of 300 mm on a concrete column of 230 x 500 mm section. Determine the maximum stress and deformation in the 4.5m long column, if the Young's modulus of concrete is 20 GPa.	Analyze & evaluate	1,2,3
20	Compute the strain energy in a steel bar (E = 200 GPa) of length 2.7 m and 22 mm diameter under a load of 50 kN. What is the resilience modulus of the bar, if the yield stress is 240 MPa?	Analyze & evaluate	1,2,3
UNIT - II SHEAR FORCE AND BENDING MOMENT			
Part – A (Short Answer Questions)			
1	What are the different types of beams?	Remembering	2
2	Differentiate between a simply supported beam and a cantilever.	Remembering	2
3	Differentiate between a fixed beam and a cantilever.	Remembering	2
4	Show by proper diagram, positive and negative shear forces at a section of a beam.	Remembering	2
5	Draw shear force diagrams for a cantilever of length L carrying a point load W at the free end.	Applying	2,4
6	Draw shear force diagrams for a cantilever of length L carrying a point load W at the mid-span.	Applying	2,4
7	Draw shear force diagram for a cantilever of length L carrying a uniformly distributed load of w per unit length over its entire span.	Applying	2,4
8	Draw shear force diagrams for a simply supported beam of length L carrying a point load W at its mid-span.	Applying	2,4
9	Draw shear force diagram for a simply supported beam of length L carrying a uniformly distributed load of w per unit length over its entire span.	Applying	2,4
10	Explain what information we obtain from shear force diagram and bending moment diagram.	Understanding	2,4
11	Draw bending moment diagrams for a cantilever of length L carrying a point load W at the free end.	Applying	2,4
12	Draw bending moment diagram for a cantilever of length L carrying a point load W at the mid-span.	Applying	2,4
13	Draw bending moment diagram for a cantilever of length L carrying a uniformly distributed load of w per unit length over its entire span.	Applying	2,4
14	Draw bending moment diagram for a simply supported beam of length L carrying a point load W at its mid-span.	Applying	2,4
15	Draw bending moment diagram for a simply supported beam of length L carrying a uniformly distributed load of w per unit length over its entire span.	Applying	2,4
16	Draw bending moment diagram for a cantilever beam of length L with a positive moment M applied at its free end.	Applying	2,4
17	Draw bending moment diagram for a simply supported beam of length L with an anti-clockwise moment M applied at the mid-span.	Applying	2,4
18	Give the mathematical relationship between rate of loading, shear force and bending moment at a section in a beam.	Remembering	2,4
19	What do you mean by point of contraflexure?	Understanding	2,4

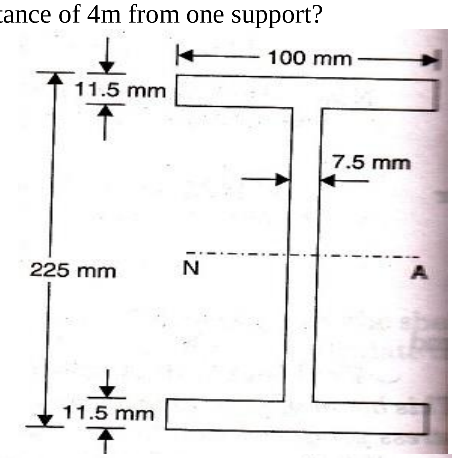
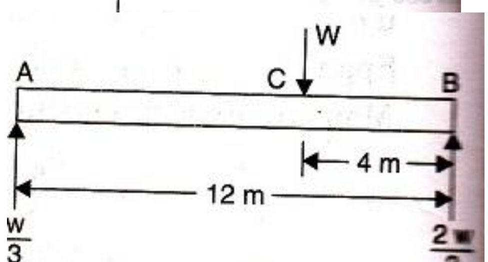
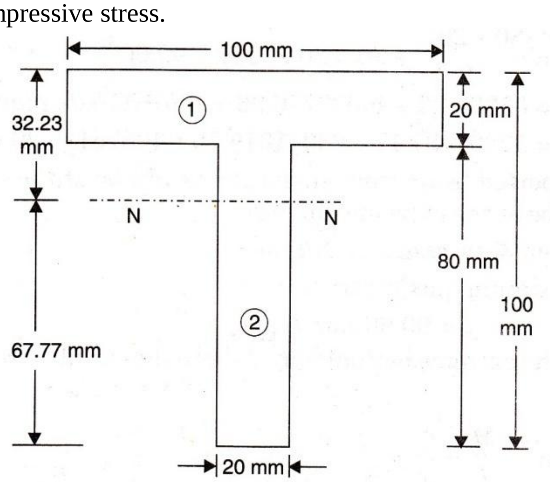
20	How many points of contraflexure you will have for simply supported beam overhanging at one end. Explain with a neat sketch.	Understanding	2,4
Part - B (Long Answer Questions)			
1	Derive the relation between rate of loading, shear force and bending moment for a beam carrying a uniformly distributed load of w per unit length over whole span.	Understanding	2,3,4
2	Derive the shear force and bending moment diagrams for a cantilever beam carrying a uniformly distributed load of w per unit run over half its span staring from the free-end.	Understanding	2,3,4
3	Draw the shear force diagrams for a cantilever beam of length 12 m carrying a uniformly distributed load of 12 kNm^{-1} over half its span staring from the free-end.	Applying	2,3,4
4	Draw the bending moment diagrams for a cantilever beam of length 12 m carrying a uniformly distributed load of 12 kNm^{-1} over half its span staring from the free-end.	Applying	2,3,4
5	Derive the shear force and bending moment diagrams for a cantilever beam carrying a uniformly varying load from zero at free end to w per unit length at the fixed end.	Applying	2,3,4
6	Draw the shear force and bending moment diagrams for a cantilever beam of length 4 m if two anti-clockwise moments of 15 kNm and 10 kNm are applied at the mid-span and the free end, respectively.	Applying	2,3,4
7	Draw the shear force and bending moment diagrams for a cantilever beam of length 7 m with a uniformly varying load from zero at fixed-end to 10 kN/m at 4m from the fixed end.	Applying	2,3,4
8	Draw the shear force and bending moment diagrams for a simply supported beam of length 12 m with an eccentric point load at a distance ‘3 m’ from the left end and at a distance of ‘4m’ from the right end.	Applying	2,3,4
9	Derive the shear force and bending moment diagrams for a simply supported beam with an eccentric point load at a distance ‘a’ from left end and at a distance ‘b’ from right end.	Applying	2,3,4
10	Derive the shear force and bending moment diagrams for a simply supported beam carrying a uniformly distributed load of *w* per unit run over whole span.	Applying	2,3,4
11	Derive the shear force and bending moment diagrams for a simply supported beam carrying a uniformly varying load from zero at each end to *w* per unit length at the centre.	Applying	2,3,4
12	Derive the shear force and bending moment diagrams for a simply supported beam carrying a uniformly varying load from zero at one end to *w* per unit length at the other end.	Applying	2,3,4
13	Draw the shear force and bending moment diagrams for a simply supported beam of length 12 m with an eccentric point load of 20 kN at a distance ‘3 m’ from the left end and of 20 kN at a distance of ‘3m’ from the right end.	Applying	2,3,4
14	Draw the shear force and bending moment diagrams for a simply supported beam of length 12 m with an eccentric point load of 25 kN at a distance ‘3 m’ from the left end and 20 kN at a distance of ‘4m’ from the right end.	Applying	2,3,4
15	Draw the shear force and bending moment diagrams for a simply supported beam of length 10 m with a point load of 15 kN at the mid-span, and a uniformly varying load from zero at 5m from left end to 10 kN/m at the right end.	Applying	2,3,4
16	Draw the shear force and bending moment diagrams for the following beam 	Applying	2,3,4

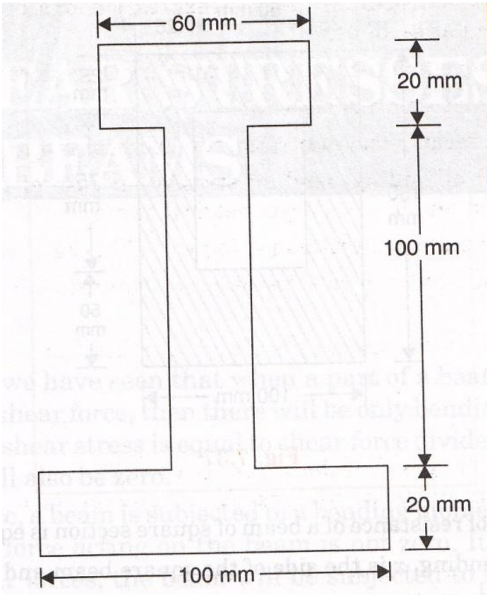
17	Draw the shear force and bending moment diagrams for the following beam. 	Applying	2,3,4
18	Draw Shear Force and Bending Moment Diagram for a simply supported beam of length 20 m, with a triangular load on it full-span, the maximum value being 16 kN/m at the mid-point of the beam.	Applying	2,3,4
19	Draw the shear force and bending moment diagrams for the following beam. 	Applying	2,3,4
20.	Draw the shear force and bending moment diagrams for the following beam. 	Applying	2,3,4
Part – C (Problem Solving and Critical Thinking)			
1	A cantilever beam of length 4m carries point loads of 1kN, 2kN and 3kN at 1, 2 and 4m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
2	A cantilever of length 4m carries a uniformly distributed load of 2kN/m run over the whole span and a point load of 2kN at a distance of 1m from the free end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
3	A cantilever of length 6m carries two point loads 2kN And 3kN at a distance of 1m and 6m from fixed end respectively. In addition to this the beam also carries a uniformly distributed load of 1kN/m over a length of 2m at a distance of 3m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
4	A cantilever of length 4m carries a uniformly distributed load of 3kN/m run over a length of 1m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
5	A cantilever of length 6m carries a gradually varying load, zero at the free end to 2kN/m at the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
6	A simply supported beam of length 8m carries point loads of 4kN and 6kN at a distance of 2m and 4m from the left end. Draw the S.F and B.M diagrams for the beam.	Analyze & evaluate	2,3,4

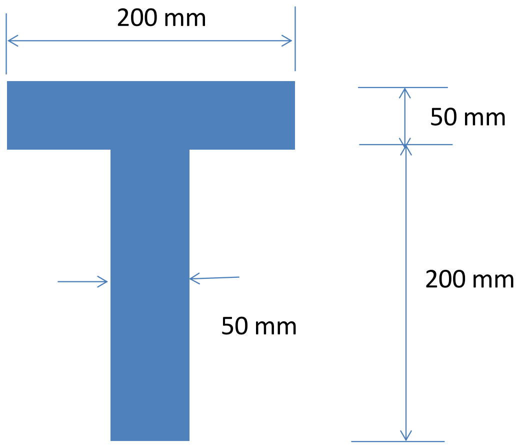
7	A simply supported beam of length 6m is carrying a uniformly distributed load of 2kN/m from the right end. Draw the S.F and B.M diagrams for the beam.	Analyze & evaluate	2,3,4
8	A beam of length 10m is simply supported and carries point loads of 5kN each at a distance of 3m and 7m from the left end and also a uniformly distributed load of 1kN/m between the point loads. Draw the S.F and B.M diagrams for the beam.	Analyze & evaluate	2,3,4
9	A beam of length 6m is simply supported at its ends. It is loaded with gradually varying load of 750N/m from left support to 1500N/m to the right support. Construct the S.F and B.M diagrams and find the amount and position of maximum B.M over the beam.	Analyze & evaluate	2,3,4
10	A simply supported beam of length 8m rests on supports 6m apart, the right hand end is overhanging by 2m. The beam carries a uniformly distributed load of 1500N/m over the entire length. Draw S.F and B.M diagrams and find the point of contraflexure, if any.	Analyze & evaluate	2,3,4
11	A cantilever beam of length 8m carries point loads of 2kN, 4kN and 6kN at 2, 4 and 8m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
12	A cantilever of length 8m carries a uniformly distributed load of 4kN/m run over the whole span and a point load of 6 kN at a distance of 2m from the free end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
13	A cantilever of length 12 m carries two point loads 4 kN and 6 kN at a distance of 2m and 6m from fixed end respectively. In addition to this the beam also carries a uniformly distributed load of 2kN/m over a length of 4m at a distance of 6m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
14	A cantilever of length 8m carries a uniformly distributed load of 4kN/m run over a length of 2m from the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
15	A cantilever of length 16m carries a gradually varying load, zero at the free end to 20 kN/m at the fixed end. Draw the S.F and B.M diagrams for the cantilever.	Analyze & evaluate	2,3,4
16	A simply supported beam of length 12 m carries point loads of 6 kN and 8 kN at a distance of 4m and 8m from the left end. Draw the S.F and B.M diagrams for the beam.	Analyze & evaluate	2,3,4
17	A simply supported beam of length 10 m is carrying a uniformly distributed load of 2kN/m for 4m from the right end. Draw the S.F and B.M diagrams for the beam.	Analyze & evaluate	2,3,4
18	A beam of length 20m is simply supported and carries point loads of 10 kN each at a distance of 6m and 14m from the left end and also a uniformly distributed load of 2 kN/m between the point loads. Draw the S.F and B.M diagrams for the beam.	Analyze & evaluate	2,3,4
19	A beam of length 12m is simply supported at its ends. It is loaded with gradually varying load of 1500N/m from left support to 3000N/m to the right support. Construct the S.F and B.M diagrams and find the amount and position of maximum B.M over the beam.	Analyze & evaluate	2,3,4
20	A simply supported beam of length 16m rests on supports 12m apart, the right hand end is overhanging by 4m. The beam carries a uniformly distributed load of 3000N/m over the entire length. Draw S.F and B.M diagrams and find the point of contraflexure, if any.	Analyze & evaluate	2,3,4
UNIT-III **FLEXURAL STRESSES, SHEAR STRESSES**			
Part - A (Short Answer Questions)			
1	Define bending stress in a beam with a diagram.	Understanding	5
2	Define pure bending and show an example by a figure.	Understanding	5
3	Define neutral axis and where is it located in a beam.	Understanding	5
4	What are the assumptions made in theory of simple bending?	Remembering	5

5	Write the bending equation, defining all the terms in the equation.	Remembering	5
6	Explain the terms: moment of resistance and section modulus	Remembering	5,6
7	Explain the role of section modulus in defining the strength of a section.	Understanding	5,6
8	Write the section modulus for a solid rectangular section.	Applying	5,6
9	Write the section modulus for a hollow rectangular section.	Applying	5,6
10	Write the section modulus for a solid circular section.	Applying	5,6
11	Of the following sections: rectangular, circular, triangular, I, T sections, which is most efficient for withstanding bending? Why?	Understanding	5,6
12	Under which conditions is the simple bending theory valid in practical applications?	Understanding	5
13	What do you mean by shear stress in beams?	Understanding	5
14	Write the expression for shear stress in a section of beam and explain the terms.	Understanding	5
15	Draw the bending stress and shear stress profiles for a rectangular beam section.	Understanding	5
16	Draw the bending stress and shear stress profiles for a circular beam section.	Understanding	5
17	Draw the bending stress and shear stress profiles for a hollow rectangular beam section.	Understanding	5
18	Draw the bending stress and shear stress profiles for a hollow circular beam section.	Understanding	5
19	Explain the concept of complimentary shear in longitudinal section of a beam which is transversely loaded.	Understanding	5
20	Of the following sections: rectangular, circular, triangular, I, T sections, which is most efficient for withstanding shearing stresses in beams? Why?	Understanding	5
Part – B (Long Answer Questions)			
1	Derive the bending equation for a beam.	Understanding	5
2	For a given stress, compare the moments of resistance of a beam of a square section, when placed (i) with its two sides horizontal and (ii) with its diagonal horizontal. Which is more suitable?	Understanding	5,6
3	Three beams have the same length, the same allowable stress and the same bending moment. The cross-section of the beams are a square, a rectangle with depth twice the width and a circle. If all the three beams have the same flexural resistance capacity, then find the ratio of the weights of the beams. Which beam is most economical?	Understanding	5,6
4	A rectangular beam 60 mm wide and 150 mm deep is simply supported over a span of 6 m. If the beam is subjected to central point load of 12 kN, find the maximum bending stress induced in the beam section.	Applying	5,6
5	A rectangular beam 300 mm deep is simply supported over a span of 4 m. What uniformly distributed load the beam may carry, if the bending stress is not to exceed 120 MPa. Take I = 225 x 10^6 mm^4 .	Applying	5,6
6	A cantilever beam is rectangular in section having 80 mm width and 120 mm depth. If the cantilever is subjected to a point load of 6 kN at the free end and the bending stress is not to exceed 40 MPa, find the span of the cantilever beam.	Applying	5,6
7	A hollow square section with outer and inner dimensions of 50 mm and 40 mm respectively, is used as a cantilever of span 1 m. How much concentrated load can be applied at the free end, if the maximum bending stress is not exceed 35 MPa?	Applying	5,6
8	A cast iron water pipe of 500 mm inside diameter and 20 mm thick is supported over a span of 10 m. Find the maximum stress in the pipe metal, when the pipe is running full. Take density of cast iron as 70.6 kN/m^3, and that of water as 9.8 kN/m^3.	Applying	5,6

9	Two wooden planks 150 mm x 50 mm each are connected to form a T-section of a beam. If a moment of 6.4 kNm is applied around the horizontal neutral axis, find the bending stresses at both the extreme fibres of the cross-section.	Applying	5,6
10	Consider the following rolled steel beam of an unsymmetrical I-Section. If the maximum bending stress in the beam section is not to exceed 40 MPa, find the maximum moment which the beam can resist. 	Applying	5,6
11	Prove that shear stress at any point in the cross-section of a beam which is subjected to a shear force F, is given by $\tau = F\frac{A\bar{y}}{bI}$	Applying	5,6
12	Show that for a rectangular section of the maximum shear stress is 1.5 times the average stress.	Applying	5,6
13	Prove that the shear stress distribution in a rectangular section of beam which is subjected to a shear force F is given by $\tau = \frac{F}{2I}(\frac{d^2}{4} - y^2)$	Applying	5,6
14	Prove that maximum shear stress in a circular section of beam is 4/3 times the average shear stress.	Applying	5,6
15	Prove that the maximum shear stress in a triangular section of a beam is given by $\tau_{max} = \frac{3F}{bh}$ where b is base width and h is height.	Applying	5,6
16	Show that the ratio of maximum shear stress to mean shear stress in a rectangular cross-section is equal to 1.50when it is subjected to a transverse shear force F. Plot the variation of shear stress across the section.	Applying	5,6
17	Sketch the distribution of shear stress across the depth of the beams of the following cross-sections: (i) T-section; (ii) square section with diagonal horizontal.	Applying	5,6
18	A rectangular beam section 100 mm wide is subjected to a maximum shear force of 50 kN. Find the depth of the beam, if the maximum shear stress is 3 MPa.	Applying	5,6
19	A circular beam of 100 mm diameter is subjected to a shear force of 30 kN. Calculate the value of maximum shear stress and sketch the variation of shear stress along the depth of the beam.	Applying	5,6
20	An I section with rectangular ends, has the following dimensions: Flanges = 150 mm x 20 mm, Web = 300 mm x 10 mm. Find the maximum shearing stress developed in the beam for a shear force of 50 kN.	Applying	5,6

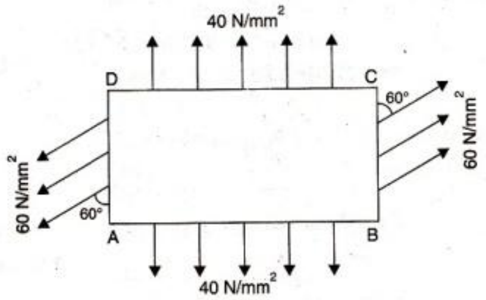
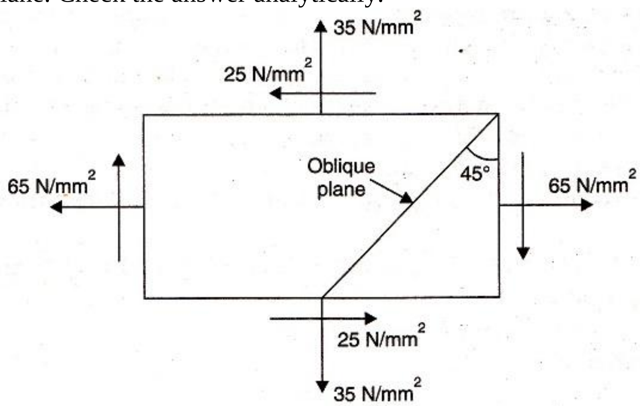
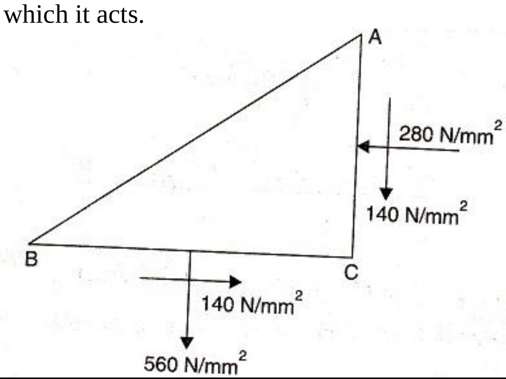
Part – C (Problem Solving and Critical Thinking)			
1	A square beam 20mm x 20mm in section and 2m long is supported at the ends. The beam fails when a point load of 400N is applied at the centre of the beam. What uniformly distributed load per meter length will break a cantilever of same material 40mm wide, 60mm deep and 3m long?	Analyze & evaluate	5,6
2	A rectangular beam is to be cut from a circular log of wood of diameter D. Find the ratio of the dimensions of the strongest section to resist bending stresses.	Analyze & evaluate	5,6
3	An I-section shown in figure is simply supported over a span of 12m. If the maximum permissible bending stress is 80N/mm^2, what concentrated load can be carried at a distance of 4m from one support?   (b)	Analyze & evaluate	5,6
4	Two circular beams where one is solid of diameter D and other is a hollow of outer dia. D_o and inner dia. D_i are of same length, same material and of same weight. Find the ratio of these circular beams.	Analyze & evaluate	5,6
5	A cast iron beam is of T-section as shown in figure. The beam is simply supported on a span of 8m. The beam carries a uniformly distributed load of 1.5kN?m length on the entire span. Determine the maximum tensile and maximum compressive stress.  	Analyze & evaluate	5,6

6	A beam of I-section shown in figure is simply supported over a span of 4m. Determine the load that the beam can carry per meter length, if the allowable stress in the beam is 30.82 N/mm^2. 	Analyze & evaluate	5,6
7	A timber beam of rectangular section is simply supported at the ends and carries a point load at the centre of the beam. The maximum bending stress is 12 N/mm^2 and maximum shearing stress is 1 N/mm^2, find the ratio of span to depth.	Analyze & evaluate	5,6
8	A circular beam of 100 mm diameter is subjected to a shear force of 5kN. Calculate: (i) average shear stress, (ii) Maximum shear stress and (iii) shear stress at a distance of 40mm from NA.	Analyze & evaluate	5,6
9	A timber beam 100mm wide and 150mm deep supports a uniformly distributed load of intensity w kN/m length over a span of 2m. If the safe stresses are 28 N/mm^2 in bending and 2 N/mm^2 in shear, calculate the safe intensity of the load which can be supported by the beam.	Analyze & evaluate	5,6
10	An I-section has the following dimensions: Flange: 150mm x 20mm, Web: 30mm x 10mm The maximum shear stress developed in the beam is 16.8 N/m^2. Find the shear force to which the beam is subjected.	Analyze & evaluate	5,6
11	The maximum shear stress in a beam of circular section of diameter 150mm is 5.28 N/mm^2. Find the shear force to which the beam is subjected.	Analyze & evaluate	5,6
12	A rectangular beam 30mm x 20mm in section and 3m long is supported at the ends. The beam fails when a point load of 600 N is applied at the centre of the beam. What uniformly distributed load per meter length will break a cantilever of same material 40mm wide, 60mm deep and 3m long?	Analyze & evaluate	5,6
13	A steel beam of rectangular section is simply supported at the ends and carries a point load at the centre of the beam. The maximum bending stress is 40 N/mm^2 and maximum shearing stress is 8 N/mm^2, find the ratio of span to depth.	Analyze & evaluate	5,6
14	An I-section beam 350 mm x 200 mm has a web thickness of 12.5 mm and a flange thickness of 25 mm. It carries a shearing force of 200 kN at a section. Sketch the shear stress distribution across the section.	Analyze & evaluate	5,6

15	A T-shaped cross-section of a beam as shown is subjected to a vertical shear force of 100 kN. Calculate the shear stress at important points and draw shear stress distribution diagram. Moment of inertia about the horizontal neutral axis is 113.4 x 10^6 mm^4.  	Analyze & evaluate	5,6
UNIT-IV PRINCIPAL STRESSES AND STRAINS, THEORIES OF FAILURE			
Part – A (Short Answer Questions)			
1	Define principal planes and principal stresses	Understanding	7,8
2	Why is it important to determine principal stresses and planes?	Understanding	7,8
3	What are the methods used to determine the stresses on oblique section?	Remembering	7,8
4	Draw the representation of biaxial state of stress at a point in a material.	Understanding	7,8
5	Draw the representation of the state of pure shear stress at a point in a material.	Understanding	7,8
6	Explain the condition of plane stress.	Understanding	7,8
7	Write the expression for normal and tangential stresses on an inclined plane for a material element subjected to combined biaxial and shear stress.	Understanding	7,8
8	Give the expression for principal stresses for the case of combined bi-axial and shear stress (plan stress condition).	Understanding	7,8
9	Give the expression for maximum shear stress for the case of combined bi-axial and shear stress (plan stress condition).	Understanding	7,8
10	Explain Mohr's circle of stresses using an example.	Understanding	7,8
11	List the various theories of failure of materials.	Remembering	9
12	State the Maximum Principal Stress Theory of Failure.	Remembering	9
13	State the Maximum Principal Strain Theory of Failure.	Remembering	9
14	State the Maximum Shear Stress Theory of Failure.	Remembering	9
15	State the Maximum Strain Energy Theory of Failure.	Remembering	9
16	State the Maximum Shear Strain Energy Theory of Failure.	Remembering	9
17	State the distortion energy theorem for failure.	Remembering	9
18	Which theory of failure is best suited for ductile materials? Why?	Understanding	9
19	Which theory of failure is best suited for brittle materials? Why?	Understanding	9
20	List the theories of material failure with their applicability to different materials	Understanding	9
Part – B (Long Answer Questions)			

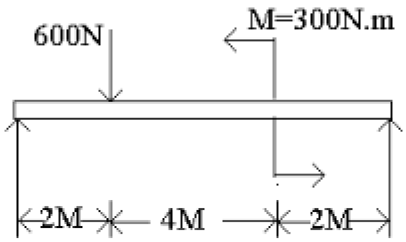
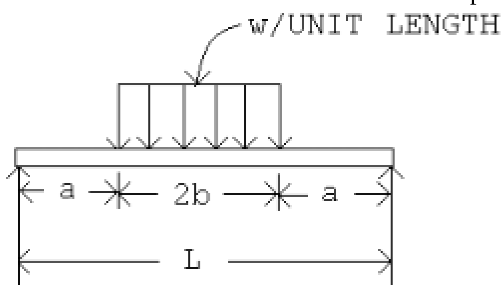
1	A rectangular bar is subjected to a direct stress (σ) in one plane only. Prove that the normal and shear stresses on an oblique plane are given by $\sigma_n = \sigma cos^2\theta$ and $\sigma_n = \frac{\sigma}{2} sin2\theta$ Where θ = angle made by oblique plane with the normal cross-section of bar σ_n = normal stress; σ_t = tangential or shear stress	Applying	7, 8
2	A rectangular bar is subjected to two direct stresses σ_1 and σ_2 in two mutually perpendicular directions. Prove that the normal stress and shear stress on an oblique plane which is inclined at an angle θ with the axis of minor stress are given by $\sigma_n = \frac{\sigma_1+\sigma_2}{2} + \frac{\sigma_1-\sigma_2}{2} cos2\theta$ and $\sigma_t = \frac{\sigma_1-\sigma_2}{2} sin2\theta$	Applying	7, 8
3	Derive an expression for the stresses on an oblique plane of a rectangular body, when the body is subjected to a simple shear stress.	Applying	7, 8
4	A rectangular body is subjected to direct stresses in two mutually perpendicular directions accompanied by a shear stress. Prove that the normal stress and shear stress on an oblique pane inclined at angle θ with the plane of major direct stress are given by $\sigma_n = \frac{\sigma_1+\sigma_2}{2} + \frac{\sigma_1-\sigma_2}{2} cos2\theta + \tau sin2\theta$ and $\sigma_t = \frac{\sigma_1-\sigma_2}{2} sin2\theta - \tau cos2\theta$	Applying	7, 8
5	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.	Applying	7, 8
6	Define and explain he theories of failure: (i) Maximum principal stress theory (ii) Maximum principal strain theory	Understanding	7, 8, 9
7	Define and explain he theories of failure: (i) Maximum shear stress theory (ii) Maximum shear strain energy theory	Understanding	7, 8, 9
8	A body is subjected to direct stresses in two mutually perpendicular principal tensile stresses accompanied by a simple shear stress. Draw the Mohr's circle of stresses and explain how you will obtain the principal stresses and strains.	Applying	7, 8
9	A body is subjected to direct stresses in two mutually perpendicular directions. How will you determine graphically the resultant stresses on an oblique plane when (i) the stresses are unequal and unlike; (ii) the stresses are unequal and like.	Applying	7, 8
10	In a two dimensional stress system, the direct stresses on two mutually perpendicular planes are 100 MN/mm^2. These planes also carry a shear stress of 25 MN/mm^2. If the factor of safety on elastic limit is 2.5, then find: (i) the value of stress when shear strain energy is minimum; (ii) elastic limit of material in simple tension.	Applying	7, 8
11	Determine the diameter of a bolt which is subjected to an axial pull of 18 kN together with a transverse shear force of 9 kN, when the elastic limit in tension is 350 N/mm^2, factor of safety = 3 and μ = 0.3 using (i) Maximum principal stress theory (ii) Maximum principal strain theory (iii) Maximum shear stress theory (iv) Maximum strain energy theorem (v) Maximum shear strain energy theory	Applying	7, 8, 9
12	A bolt is under an axial thrust of 10 kN together with a transverse shear force of 4 kN. Calculate the diameter of bolt according to (i) Maximum principal stress theory (ii) Maximum shear stress theory (iii) Maximum strain energy theorem Take elastic limit in simple tension = 225 N/mm^2, factor of safety = 3, μ = 0.3.	Applying	7, 8, 9

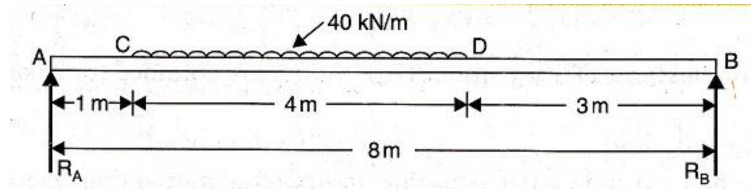
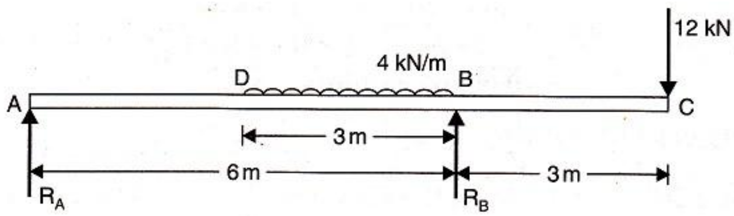
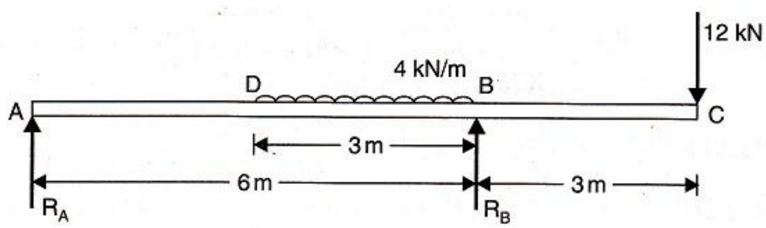
13	The principal stresses at a point in a elastic material are 25 N/mm^2 (tensile), 100 N/mm^2 (tensile) and 50 N/mm^2 (compressive). If the elastic limit in simple tension is 220 N/mm^2 and μ = 0.3, then determine whether the failure of material will occur or not according to (i) Maximum principal stress theory (ii) Maximum principal strain theory (iii) Maximum shear stress theory (iv) Maximum strain energy theorem Maximum shear strain energy theory	Applying	7, 8, 9
14	The principal stresses at a point in a elastic material are 30 N/mm^2 (tensile), 120 N/mm^2 (tensile) and 50 N/mm^2 (compressive). If the elastic limit in simpletension is 250 N/mm^2 and μ = 0.3, then determine whether the failure of material will occur or not according to (iii) Maximum principal stress theory (iv) Maximum principal strain theory (v) Maximum shear stress theory (vi) Maximum strain energy theorem (vii) Maximum shear strain energy theory	Applying	7, 8, 9
15	The stresses at a point in a bar are 250 N/mm^2 (tensile) and 150 N/mm^2(compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 30^o to the axis of major stress. Also determine the maximum intensity of shear stress in the material at that point.	Applying	7, 8
16	The normal stress in two mutually perpendicular directions are 500 N/mm^2 and 320 N/mm^2 both tensile. The complimentary shear stress in these directions is of intensities 350 N/mm^2. Find the normal and tangential stresses on the two planes which are equally inclined to the plane carrying the normal stress mentioned above.	Applying	7, 8
17	The axial stresses at a point in a bar are -100 N/mm^2 and 150 N/mm^2, and the shear stress is 150 N/mm^2. Determine the maximum intensity of shear stress in the material at that point.	Applying	7, 8
18	The normal strains in two mutually perpendicular directions are -2.3 and 5.0 and shear strain is 3.0. Find the minimum and maximum values of the strains.	Applying	7, 8
19	A bolt of 12 mm diameter is subjected to an axial pull of 10 kN and a shear force of 7.5 kN. Determine the factor of safety against failure based on various theories, if the yield strength of the material is 400 MPa, and Poisson's ratio is 0.3.	Applying	7, 8
20	A bolt of 18 mm diameter is subjected to an axial force of 25 kN. Determine the maximum shear force the bolt can sustain according to various theories, if the yield strength of the material is 340 MPa, and factor of safety is 1.8.	Applying	7, 8
Part – C (Problem Solving and Critical Thinking)			
1	The stresses at a point in a bar are 200 N/mm^2 (tensile) and 100 N/mm^2(compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 60^o to the axis of major stress. Also determine the maximum intensity of shear stress in the material at that point.	Analyze & evaluate	7, 8

2	A point in a strained material is subjected to the stresses as shown in figure. Locate the principal planes, and evaluate the principal stresses.  	Analyze & evaluate	7, 8
3	The normal stress in two mutually perpendicular directions are 600 N/mm^2 and 300 N/mm^2 both tensile. The complimentary shear stress in these directions is of intensities 450 N/mm^2. Find the normal and tangential stresses on the two planes which are equally inclined to the plane carrying the normal stress mentioned above.	Analyze & evaluate	7, 8
4	The normal stress in two mutually perpendicular directions are 520 N/mm^2 and 360 N/mm^2 both tensile. The complimentary shear stress in these directions is of intensities 420 N/mm^2. Find the normal and tangential stresses on the two planes which are equally inclined to the plane carrying the normal stress mentioned above.	Analyze & evaluate	7, 8
5	A point in a strained material is subjected to stress shown in figure. Using Mohr's circle method, determine the normal and tangential stresses across the oblique plane. Check the answer analytically.  	Apply & evaluate	7, 8
6	At a point in a strained material, on plane BC there are normal and shear stresses of 560 N/mm^2 and 140 N/mm^2 respectively. On plane AC, perpendicular to plane BC, there are normal and shear stresses of 280 N/mm^2 and 140 N/mm^2 respectively as shown in the figure. Determine the following: (i) principal stresses and location on which they act; (ii) maximum shear stress and the plane on which it acts.  	Analyze & evaluate	7, 8

7	The principal stresses at a point in a elastic material are 22 N/mm^2 (tensile), 110N/mm^2 (tensile) and 55 N/mm^2 (compressive). If the elastic limit in simpletension is 220 N/mm^2 and μ = 0.3, then determine whether the failure of material will occur or not according to (v) Maximum principal stress theory (vi) Maximum principal strain theory (viii) Maximum shear stress theory (ix) Maximum strain energy theorem (x) Maximum shear strain energy theory	Analyze & evaluate	7, 8, 9
8	Determine the diameter of a bolt which is subjected to an axial pull of 12 kN together with a transverse shear force of 6kN, when the elastic limit in tension is 300 N/mm^2, factor of safety = 3 and μ = 0.3 using (vi) Maximum principal stress theory (vii) Maximum principal strain theory (viii) Maximum shear stress theory (ix) Maximum strain energy theorem (x) Maximum shear strain energy theory	Analyze & evaluate	7, 8, 9
9	A bolt is under an axial thrust of 7.2 kN together with a transverse shear force of 3.6kN. Calculate the diameter of bolt according to (iv) Maximum principal stress theory (v) Maximum shear stress theory (vi) Maximum strain energy theorem Take elastic limit in simple tension = 202 N/mm^2, factor of safety = 3, μ = 0.3.	Analyze & evaluate	7, 8, 9
10	In a two dimensional stress system, the direct stresses on two mutually perpendicular planes are 120MN/mm^2. These planes also carry a shear stress of 40MN/mm^2. If the factor of safety on elastic limit is 3, then find: (i) the value of stress when shear strain energy is minimum; (ii) elastic limit of material in simple tension.	Analyze & evaluate	7, 8, 9
11	Determine the maximum stresses in the body for the stress conditions: σ_x = 80 N/mm^2, σ_y = -100 N/mm^2 and τ_{xy} = -150 N/mm^2. The complimentary shear stress in these directions is of intensities 350 N/mm^2. Indicate their planes, and the stresses on the planes inclined at 30^o and – 60^o with the Y-axis.	Analyze & evaluate	7, 8, 9
12	* Develop Mohr's circle for the stress conditions σ_x = +300 N/mm^2, σ_y = -400 N/mm^2 , σ_z = +100 N/mm^2 and τ_{xy} = -250 N/mm^2. Determine the magnitudes and the planes of principal stresses and maximum shear stresses (DSPR).	Analyze & evaluate	7, 8, 9
13	* Stresses at a point in a body are estimated as σ_0 = +150 N/mm^2, σ_{45} = +250 N/mm^2 and σ_{60} = +100 N/mm^2. Determine the principal stresses and maximum shear stress along with their planes. The subscripts indicate the orientation of the stress direction with the x-axis.	Analyze & evaluate	7, 8, 9
14	Determine the planes of principal strains and maximum shear strains, if the strains measured in a body are ε_x = 1.25 , ε_y = 3.25 and ε_{60} = 3, the values being in the units of microstrains.	Analyze & evaluate	7, 8, 9
15	Determine the planes of principal strains and maximum shear strains, if the strains measured in a body are ε_x = 2.85 , ε_{60} = -7 and ε_{120} = -5, the values being in the units of microstrains.	Analyze & evaluate	7, 8, 9
	UNIT-V **DEFLECTION OF BEAMS**		
	Part - A (Short Answer Questions)		
1	Define deflection and slope of a beam.	Remembering	10
2	Write the differential equation for the beam	Remembering	10
3	List the different methods for finding slope and deflection of a beam.	Remembering	10
4	Explain the concept of double-integration method to obtain the deflections of a beam	Understanding	10

5	Give the relation between the load, shear force and bending moment at a section of a beam.	Remembering	10
6	What is Macaulay's method? How is it different from the general double integration method?	Understanding	10
7	What is meant by flexural rigidity? Give its expression.	Remembering	10
8	Give the slope and deflection of a cantilever beam, with flexural rigidity *EI*, and length L, carrying a point load W at its free end?	Remembering	10
9	Give the slope and deflection of a simply supported beam, with flexural rigidity *EI*, and length L, carrying a point load W at its mid-span?	Remembering	10
10	State and explain the first theorem of Mohr.	Understanding	10
11	State and explain the second theorem of Mohr.	Understanding	10
12	How is moment area method used to calculate deflection of the free end of a cantilever? (Note: Just explain the concept and procedure in brief. Do not do calculations)	Understanding	10
13	Explain the concept of conjugate beam method.	Understanding	10
14	What is the advantage of the conjugate beam method over other methods?	Understanding	10
15	Write the boundary support conditions for slope and deflections of a cantilever, and write the same for its conjugate beam.	Understanding	10
16	Write the boundary support conditions for slope and deflections of a simply supported beam, and write the same for its conjugate beam.	Understanding	10
17	Draw the conjugate beam for a propped cantilever beam (one end fixed and other end on roller support).	Understanding	10
18	Draw the conjugate beam for a simply supported beam with an overhang on other end.	Understanding	10
19	How will you use conjugate beam method for finding slope and deflection at any section of a given beam?	Understanding	10
20	What is the relation between an actual beam and the corresponding conjugate beam for different end conditions?	Understanding	10
Part - B (Long Answer Questions)			
1	Derive an expression for slope and deflection of a beam subjected to uniform bending moment.	Applying	10
2	Prove that the relation $M = EI\frac{d^2y}{dx^2}$ where M is the bending moment and E is modulus of elasticity and I is moment of inertia of the beam section.	Applying	10
3	Prove that the deflection at centre of a simply supported beam, carrying a point load at centre, is given by $y_c = \frac{WL^3}{48EI}$	Applying	10
4	Derive the slope at supports and deflection at centre for a simply supported beam carrying uniformly distributed load of *w* per unit length over the entire span.	Applying	10
5	Use Moment-Area method to find the slope and deflection of a simply supported beam carrying a point load at the centre.	Applying	10
6	Use Moment-Area method to find the slope and deflection of a simply supported beam carrying a uniformly distributed load over the entire span.	Applying	10
7	Derive slope and deflection of a cantilever carrying uniformly distributed load over whole length using Macaulay's method.	Applying	10
8	Derive slope and deflection of a cantilever carrying uniformly distributed load over a length 'a' from the fixed end by double integration method.	Applying	10
9	Derive slope and deflection of a cantilever carrying uniformly distributed load over a length 'a' from the fixed end by Moment-Area method.	Applying	10
10	Derive slope and deflection relations for a cantilever carrying a gradually varying load from zero at the free end to *w* per metre run at the fixed end.	Applying	10
11	Find the slope and deflection of a simply supported beam carrying a point load centre, using conjugate beam method.	Applying	10
12	A cantilever carries a point load at the free end. Determine the deflection at free end using conjugate beam method.	Applying	10

13	Determine the deflection of the beam at the point of application of the 300 Nm couple as shown in the figure. Take E = 2 x 10^5 N/mm^2 and I = 200 cm^4.  	Applying	10
14	A simply supported beam shown in the Figure carries a uniformly distributed load of intensity w symmetrically distributed over part of its length. Determine the maximum deflection and check your results by assuming a = 0 and compare, when same beam is with u.d.l. on the entire span.  	Applying	10
15	A steel Cantilever of 2.5m effective length carries a load of 25 kN at its free end. If the deflection at the free end is not to exceed 0.5 cm, what must be the I value of the section of the cantilever? Use Moment Area Method. Take E = 210 GPa.	Applying	10
16	A simply supported beam 5 m long carries concentrated loads of 10 kN each at a distance 1m from the ends. Calculate: (a) Maximum slope and deflection for the beam, and (b) Slope and deflection under each load. Take: EI = 1.2 × 10^4 kN.m^2.	Applying	10
17	A cantilever of length L is loaded with uniformly varying load of intensity zero at the free end and w/unit length at the fixed end. Derive an expression for the deflection at any point. Find also the slope and deflection of the free end.	Applying	10
18	A beam 6 m long, simply supported at its ends, is carrying a point load of 50 kN at its centre. The moment of inertia of the beam is given as equal to 78 × 10^6 mm^4. If E for the material of the beam = 2.1 × 10^5 N/mm^2, Calculate: (a) deflection at the centre of the beam, and (b) slope at the supports.	Applying	10
19	A simply supported beam of circular cross-section is 5 m long and is of 150 mm diameter. What will be the maximum value of the central load if the deflection of the beam does not exceed 12.45 mm. Also calculate the slope at the supports. Take E = 2 × 10^8 kN/m^2.	Applying	10
20	A cantilever of 4m span length carries a load 40 KN at its free end. If the deflection at the free end is not to exceed 8mm, what must be the moment of inertia of the Cantilever section?	Applying	10
Part – C (Problem Solving and Critical Thinking)			
1	A beam of length 6m is simply supported at its ends and carries two point loads of 48kN and 40kN at a distance of 1m and 3m respectively from the left support. Find: (i) deflection under each load, (ii) maximum deflection and (iii) the point at which maximum deflection occurs. Given E = 2 x 10^5 N/mm^2 and I = 85 x 10^6 mm^4.	Apply & evaluate	10

2	A beam of length 8m is simply supported at is ends. It carries a uniformly distributed load of 40kN/m as shown in figure below. Determine the deflection of the beam at its midpoint and also the position of maximum deflection and maximum deflection. Take E = 2 x 10^5 N/mm^2 and I = 4.3 x 10^8 mm^4. 	Apply & evaluate	10
3	A beam ABC of length 9m has one support to the left end and the other support at a distance of 6m from the left end. The beam carries a point load of 1kN at the right end and also carries a uniformly distributed load of 4kN/m over a length of 3m as shown in the figure. Determine slope and deflection at point C. E = 2 x 10^5 N/mm^2 and I = 5 x 10^8 mm^4. 	Apply & evaluate	10
4	A beam of 4.8m and of uniform rectangular section is simply supported at its ends. It carries a uniformly distributed load of 9.375kN/m run over the entire length. Calculate the width and depth of the beam if permissible bending stress is 7N/mm^2 and maximum deflection is not to exceed 0.95cm. Take E for beam material = 1.05 x 10^4 N/mm^2	Apply & evaluate	10
5	A beam ABC of length 9m has one support to the left end and the other support at a distance of 6m from the left end. The beam carries a point load of 1kN at the right end and also carries a uniformly distributed load of 4kN/m over a length of 3m as shown in the figure. Determine slope and deflection at point C. E = 2 x 10^5 N/mm^2 and I = 5 x 10^8 mm^4. Use moment–area method. 	Apply & evaluate	10
6	Determine the deflection at the free end of a cantilever which is 2m long and carries a point load of 9kN at the free end and a uniformly distributed load of 8kN/m over a length of 1m from the fixed end. Take E = 2.2 x 10^5 N/mm^2 and I = 2.25 x 10^7 mm^4.	Apply & evaluate	10
7	A cantilever of length 2m carries a uniformly varying load of zero intensity at free end and 45kN/m at the fixed end. If E = 2 x 10^5 N/mm^2 and I = 10^8mm^4, find the slope and deflection of the free end.	Apply & evaluate	10
8	A cantilever of length 2m carries a point load of 3kN at the free end and another load of 30kN at its centre. If EI = 10^{13} N/mm^2 for the cantilever, then determine by moment area method, the slope and deflection at the free end of cantilever.	Apply & evaluate	10
9	A beam of length 6m is simply supported at it ends and carries two point loads of 48kN and 40kN at a distance of 1m and 3m respectively from the left support. Find the deflection under each load. Take E = 2 x 10^5 N/mm^2 and I = 85 x 10^6 mm^4. Use conjugate beam method.	Apply & evaluate	10

10	A cantilever of length 3m is carrying a point load of 50kN at a distance of 2m from the fixed end. If I = $10^8 mm^4$ and E = 2 x 10^5 N/mm^2, find slope and deflection at free end using conjugate beam method.	Apply & evaluate	10
11	A steel girder of uniform section, 14 meters long, is simply supported at its ends. It carries concentrated loads of 120 kN and 80 kN at two points 3 meters and 4.5 meters from the two ends respectively. (a) Calculate the deflection of the girder at the two points under the two loads: (b) The maximum deflection. Use Macaulay's Method. Take: I = $16 \times 10^4 m^4$, and E = 210×10^6 kN/m^2.		10
12	A horizontal beam of uniform section and length L rests on supports at its ends. It carries a U.D.L. w per unit length which extends over a length 'a' form the right hand support. Determine the value of 'a' in order that the maximum deflection may occur at the left hand end of the load, and if the maximum deflection is wl^4/k E I' determine the value of k.	Analyze & evaluate	10
13	Show that the central deflection in a symmetrical double over hanging beam of span L and over hangs "a" with concentrated loads W at free ends is $Wal^2/8EI$.	Analyze & evaluate	10
14	A horizontal beam of uniform section is pinned at its ends which are at the same level and is loaded at the left hand pin with an anticlockwise moment M and at the right hand pin with a clockwise moment 2m both in the same vertical plane. The length between the pins is L. Find the angles of slope at each end and the deflection of the midpoint of the span in terms of M, L, E and I.	Analyze & evaluate	10
15	Determine the maximum deflection and the slope of the beam as shown in the figure using any one of the following methods: (a) Macaulay's method (b) moment-Area method (c) Conjugate beam method  	Analyze & evaluate	10

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