INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**MECHANICS OF SOLIDS**				
Course Code	AAEB04				
Programme	B.Tech				
Semester	III	AE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. G S D Madhav Assistant Professor				
Course Faculty	Ms. Y Shwetha, Assistant Professor Mr. G S D Madhav Assistant Professor				

COURSE OBJECTIVES

The course will enable the students to:	
I	Understand the behavior of structure basic structural components under loading conditions.
II	Apply the shear force, bending moment and deflection methods to the beam in different load conditions.
III	Relate the bending and flexural stress solving methods to real time problems.
IV	Pertain the concept of buckling behavior of the columns along with eigen modes.
V	Discuss the equilibrium and compatibility conditions for two-dimensional and three-dimensional elastic bodies.

COURSE OUTCOMES (COs):

CO 1	To understand the basics of material properties, stress and strain.
CO 2	To apply knowledge of various kinds of beams for engineering applications.
CO 3	Ability to identify, formulates, and solves engineering & real life problems.
CO 4	Ability to design and conduct experiments, as well as to analyze and interpret data
CO 5	Ability to design a component to meet desired needs within realistic constraints of safety.

TUTORIAL QUESTION BANK

MODULE-I				
INTRODUCTION TO STRESSES & STRAINS				
Part - A (Short Answer Questions)				
S. No	Question	Blooms Taxonomy Level	Course Outcome	Course Learning Outcome
1	Define Longitudinal strain and lateral strain.	Remember	CO 1	AAEB04.01
2	State Hooke's law	Remember	CO 1	AAEB04.01
3	Define Modular ratio, Poisson's ratio	Remember	CO 1	AAEB04.01
4	What is modulus of elasticity?	Remember	CO 1	AAEB04.01
5	Explain lateral strain with a neat sketch	Remember	CO 1	AAEB04.01
6	Write the relationship between bulk modulus, rigidity modulus and Poisson's Ratio	Remember	CO 1	AAEB04.01
7	Explain shear force in a beam with neat sketches	Remember	CO 1	AAEB04.01
8	What are the different types of beams? Differentiate between a point load and a uniformly distributed load.	Remember	CO 1	AAEB04.01
9	What is the maximum bending moment for a simply supported beam subjected to uniformly distributed load and where it occurs?	Remember	CO 1	AAEB04.01
10	Write the relation between bending moment, shear force and the applied load.	Remember	CO 1	AAEB04.01
11	Define Modular ratio, Poisson's ratio	Understand	CO 1	AAEB04.03
12	What is modulus of elasticity?	Remember	CO 1	AAEB04.04
13	Explain lateral strain with a neat sketch	Understand	CO 1	AAEB04.01
14	Write the relationship between bulk modulus, rigidity modulus and Poisson's Ratio	Remember	CO 1	AAEB04.02
15	Draw the stress-strain diagram for mild steel, brittle material and a ductile material and indicate the salient points	Understand	CO 1	AAEB04.03
16	What is Principle of Superposition?	Remember	CO 1	AAEB04.04
17	What is the procedure for finding the thermal stresses in a composite bar?	Remember	CO 1	AAEB04.01
18	Define Factor of Safety, working stress and allowable stress.	Remember	CO 1	AAEB04.02
19	Define Resilience. What is proof resilience?	Understand	CO 1	AAEB04.03
20	What is torsion? How polar modulus is related to torsion ?	Understand	CO 1	AAEB04.04
Part - B (Long Answer Questions)				
1	Three sections of a bar are having different lengths and different diameters. The bar is subjected to an axial load P. Determine the total change in length of the bar. Take Young's modulus of different sections as same.	Understand	CO 1	AAEB04.01
2	Prove that the total extension of a uniformly tapering rod of diameters D_1 & D_2, when the rod is subjected to an axial load P is given by $dL= 4PL/(\pi E\, D_1\, D_2)$ where L is total Length of the rod.	Understand	CO 1	AAEB04.01
3	Find an expression for the total elongation of a bar due to its own weight, when the bar is fixed at its upper end and hanging freely at the lower end.	Understand	CO 1	AAEB04.01
4	Find an expression for the total elongation of a uniformly tapering rectangular bar when it is subjected to an axial load P.	Remember	CO 1	AAEB04.01
5	Derive the relation between three elastic modulus.	Understand	CO 1	AAEB04.01
6	Define Volumetric Strain. Prove that the volumetric strain for a rectangular bar subjected to an axial load P in the direction of its length is given by $\varepsilon_V= (\delta l/l)(1-2\mu)$ Where μ= Poisson's Ratio and $\delta l/l$ = longitudinal strain.	Understand	CO 1	AAEB04.01

7	Derive an expression between modulus of elasticity and modulus of rigidity.	Understand	CO 1	AAEB04.01
8	Prove that the stress induced in the body when the load is applied with the impact is given by, $\sigma = \frac{P}{A}\left(1+\sqrt{1+\frac{2AEh}{P.L}}\right)$ A=cross-section area of the body H=height through which load falls E= modulus of rigidity L=length of the body	Understand	CO 1	AAEB04.01
9	Prove that the maximum stress induced in a body due to suddenly applied load is twice the stress induced when the same load is applied gradually.	Remember	CO 1	AAEB04.02
10	If the extension produced in a rod due to impact load is very small in comparison with the height through which the load falls, then the maximum stress induced in the body is given by $\sigma = \sqrt{\frac{2E.P.h}{A.L}}$	Understand	CO 1	AAEB04.01
11	Prove that the torque transmitted by the solid shaft when subjected to torsion is given by $T = \frac{\pi}{16}\tau D^3$	Understand	CO 1	AAEB04.01
12	Derive the relation for a circular shaft when subjected to torsion as given below $\frac{T}{J} = \frac{\tau}{R} = \frac{C\theta}{L}$	Understand	CO 1	AAEB04.04
13	Find the expression for strain energy stored in a body due to torsion.	Understand	CO 1	AAEB04.02
14	A hollow shaft of external diameter D and internal diameter d is subjected to torsion. Prove that the strain energy stored is given by $U = \frac{\tau^2}{4CD^2}(D^2 + d^2) \times V$	Understand	CO 1	AAEB04.03
15	A solid shaft of 20cm diameter is used to transmit torque. Find the maximum shaft transmitted by the torque if the maximum shear stresses induced in the shaft is $50N/mm^2$	Understand	CO 1	AAEB04.04
16	The shearing stress in a solid shaft is not to exceed $45N/mm^2$ when the torque transmitted 40000N-m. Determine the minimum diameter of the shaft.	Understand	CO 1	AAEB04.01
17	Two shafts of same material and of same lengths are subjected to the same torque if the first shaft is of a solid circular section and the second shaft is of hollow circular section whose internal diameter is 0.7 times the outside diameter and the maximum shear stress developed in each shaft is same compare the weights of the shafts.	Remember	CO 1	AAEB04.02
18	Find the maximum shear stress induced in a solid circular shaft of diameter 20cm when shaft transmit 187.5KW at 2000 r.p.m.	Understand	CO 1	AAEB04.03
19	A solid shaft has to transmit 12.5KW at 250 r.p.m taking allowable shear stress as $70N/mm^2$. Find suitable diameter for the shaft if maximum torque transmitted at each revolution exceeds the main by 20%.	Remember	CO 1	AAEB04.04

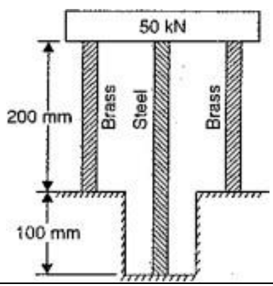
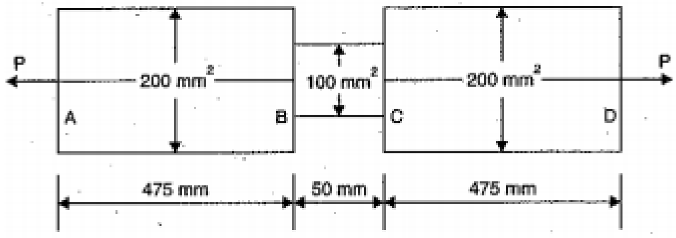
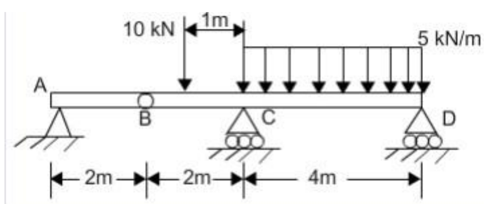
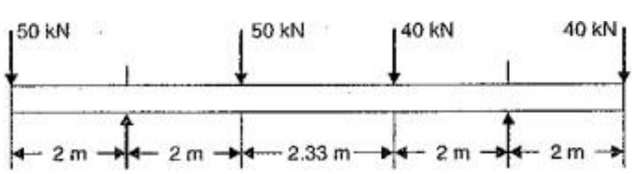
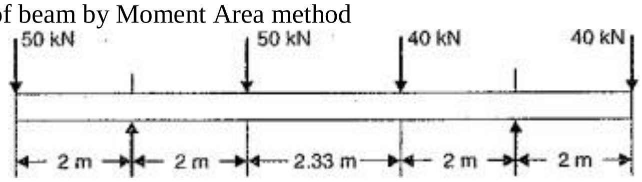
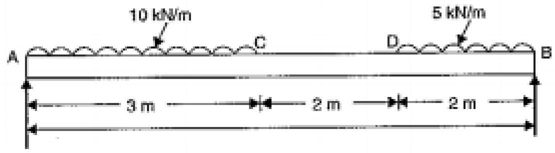
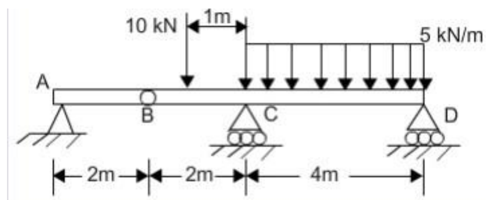
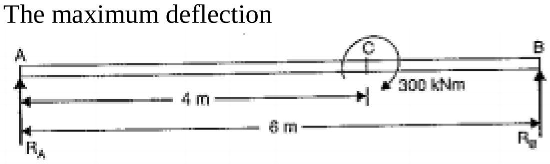
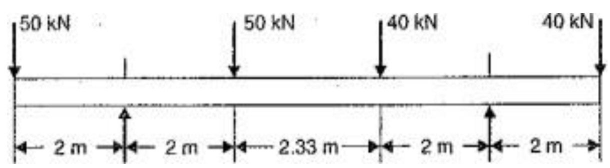
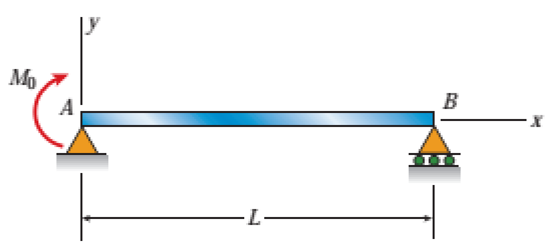
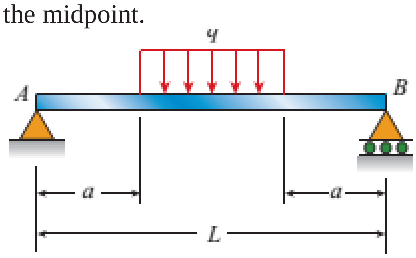
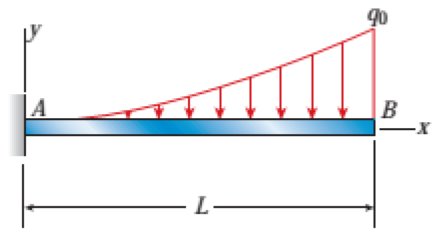
20	A bar of uniform cross-section A and length L hangs vertically, subjected to its own weight. Prove that the strain energy stored within the bar is given by $$U=\frac{A\times\rho^2\times L^3}{6E}$$ Where E = Modulus of elasticity ρ = weight per unit volume.	Understand	CO 1	AAEB04.01
Part - C (Problem Solving and Critical Thinking Questions)				
1	Find the minimum diameter of a steel wire with which a load of 3500N can be raised so that the stress in the wire may not exceed 130N/mm^2. For the size and the length of the middle portion if the stress there is 140N/mm^2 and the total extension of the bar is 0.14mm. take E= 2×10^5 N/mm^2.	Understand	CO 1	AAEB04.01
2.	A copper rod 5mm in diameter when subjected to a pull of 750 N extends by 0.125mm over a gauge length of 327mm. find the Young's Modulus for copper.	Understand	CO 1	AAEB04.01
3	A steel punch can operate at a maximum compressive stress of 75N/mm^2. Find the minimum diameter of the hole which can be punched through a 10mm thick steel plate. Take the ultimate shearing strength as 375N/mm^2	Understand	CO 1	AAEB04.01
4	A steel rod of cross-sectional area 1600mm^2 and two brass rods each of cross-sectional area of 1000mm^2 together support a load of 50KN as shown in figure. Find the stresses in the rods. Take E for steel 2×10^5 N/mm^2 and E for brass 1×10^5 N/mm^2 	Remember	CO 1	AAEB04.01
5	A steel rod 5 cm diameter and 6 m long is connected to two grips and the rod is maintained at a temperature of 100^{0}C. determine the stress and pull exerted when the temperature falls to 20^{0}C if (i) The ends do not yield (ii) The ends yield by 0.15cm Take E = 2×10^5 N/mm^2 and $\alpha=12\times10^{-}/^{o}C$	Remember	CO 1	AAEB04.01
6	The extension in a rectangular steel bar of length 800mm and of thickness 20mm is found to be 0.21mm. The bar tapers uniformly in width from 80mm to 40mm. if E for the bar is 2×10^5 N/mm^2. Determine the axial tensile load on the bar.	Understand	CO 1	AAEB04.01
7	The maximum stress produced by a pull in a bar of length 1m is 150N/mm^2. The area of cross-sections and length are shown in	Understand	CO 1	AAEB04.02

	figure. Calculate the strain energy stored in the bar if E=2 $\times 10^5 N/mm^2$.  			
8	A load of 100N falls through a height of 2cm on to a collar rigidly attached to the lower end of a vertical bar 1.5m long and of $1.5cm^2$ cross-sectional area. The upper end of the vertical bar is fixed. Determine: i. Maximum instantaneous stress induced in the vertical bar, ii. Maximum instantaneous elongation and iii. Strain energy stored in the vertical rod. Take E=2 $\times 10^5 N/mm^2$	Understand	CO 1	AAEB04.02
9	A vertical bar 4m long and 2000 mm2 cross-sectional area is fixed at the upper end and has a collar at the lower end. Determine the maximum stress induced when a weight of: i. 3000 N falls through a height of 20cm on the collar, ii. 30KN falls through a height of 2 cm on the collar. Take E=2 $\times 10^5 N/mm^2$	Remember	CO 1	AAEB04.01
10	The shear stress in a material at a point is given as 45 N/mm^2. Determine the local strain energy per unit volume stored in the material due to shear stress. Take C=8 $\times 10^4 N/mm^2$	Understand	CO 1	AAEB04.02
MODULE -II				
FORCES, DEFLECTIONS IN BEAMS				
Part - A (Short Answer Questions)				
1	Explain what is shear force?	Remember	CO 2	AAEB04.04
2	What are the types of beams we have? Draw the neat sketches.	Understand	CO 2	AAEB04.04
3	Explain the rules to draw the shear force and bending moment diagrams.	Understand	CO 2	AAEB04.04
4	What are the sign conventions for shear force and bending moment?	Remember	CO 2	AAEB04.04
5	What is a Macaulay's method? Where is it used?	Remember	CO 2	AAEB04.06
6	What is moment-area method? Where is it conveniently used?	Remember	CO 2	AAEB04.05
7	Prove the relation that $M = EI \frac{d^2y}{dx^2}$	Remember	CO 2	AAEB04.05
8	What is equation of slope for a SSB of length L and carrying a UDL of w/unit length over the entire length?	Remember	CO 2	AAEB04.05
9	What is equation of deflection for a SSB of length L and carrying a UDL of w/unit length over the entire length?	Remember	CO 2	AAEB04.04
10	Write the deflection at the centre of a SSB carrying a point load W at a distance 'a' from left support and at a distance 'b' from right support where a>b.	Remember	CO 2	AAEB04.04
11	Write the relation between slope Θ and deflection y at a section.	Understand	CO 2	AAEB04.05
12	Write the relation between bending moment M and deflection y at a section.	Remember	CO 2	AAEB04.06
13	Write the relation between shear force F and deflection y at a section.	Understand	CO 2	AAEB04.07

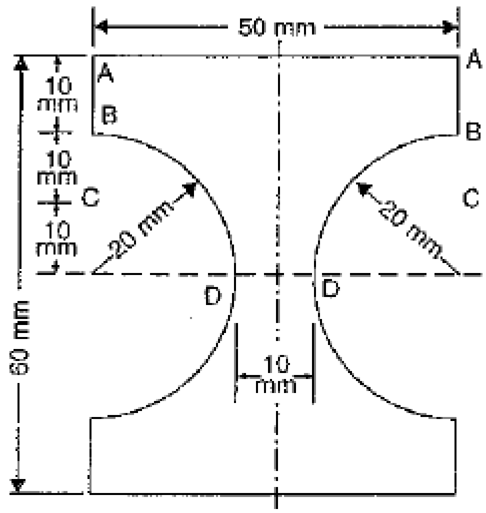
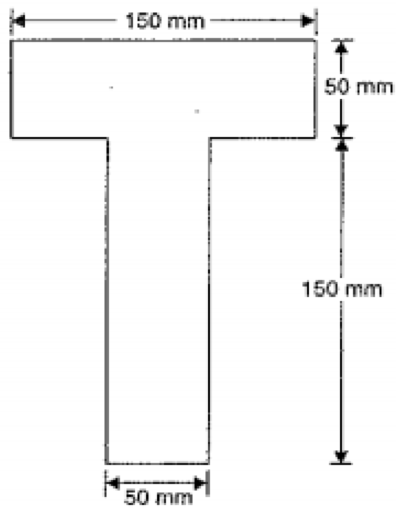
14	Write the relation between udl w and deflection y at a section.	Remember	CO 2	AAEB04.08
15	Write the expression for slope at the supports of a SSB carrying a point load at the center.	Understand	CO 2	AAEB04.05
16	What are the rules to follow to determine the deflection by Macaulay's method?	Remember	CO 2	AAEB04.06
17	What will be the value of slope at the point of maximum deflection?	Understand	CO 2	AAEB04.07
18	Write the expression of slope at point B if slope at A is zero by moment area method.	Remember	CO 2	AAEB04.08
19	Write the deflection equation for a beam by moment area method and explain the terms.	Understand	CO 2	AAEB04.05
20	What are propped cantilever beams?	Remember	CO 2	AAEB04.06
Part - B (Long Answer Questions)				
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. Take E = $2x10^5 N/mm^2$ and $I=85x10^6 mm^4$	Understand	CO 2	AAEB04.04
2	A cantilever of length 3 m is carrying a point load of 50KN at a distance of 2m from the fixed end. If I= 10^8 mm^4 and $E=2x10^5 N/mm^2$ find the slope and deflection at the free end.	Remember	CO 2	AAEB04.04
3	Evaluate deflection of beam by Double integration method 	Remember	CO 2	AAEB04.02
4	A beam is loaded as shown in the figure Evaluate deflection of beam by MacAulay's method 	Remember	CO 2	AAEB04.05
5	A beam is loaded as shown in the figure Evaluate deflection of beam by Moment Area method 	Remember	CO 2	AAEB04.04
6	A cantilever of length 2 m carries a udl of 1kN/m run over a length of 1.5m from the free end. Draw the shear force and bending moment diagrams for the cantilever.	Remember	CO 2	AAEB04.04
7	A cantilever of length 4m carries a gradually varying load, zero at the free end to 2kN/m at the fixed end. Draw the shear force and bending moment diagrams for the cantilever.	Understand	CO 2	AAEB04.05
8	Draw the shear force and bending moment diagrams of a	Remember	CO 2	AAEB04.04

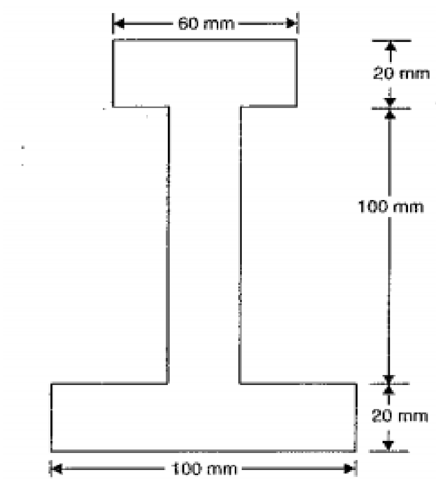
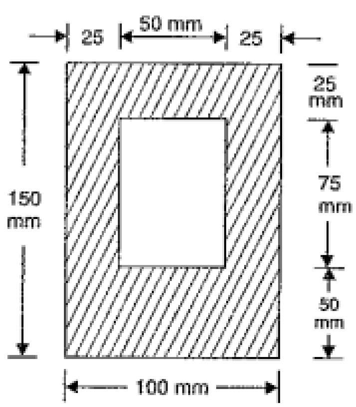
	simply supported beam of length 7 m carrying uniformly distributed loads as shown in the figure.  			
9	Draw S.F.D and B.M.D for a SSB carrying uniformly varying load from zero at each end to w per unit length at the center.	Remember	CO 2	AAEB04.04
10	A SSB of length 5 m carries a uniformly increasing load of 800 N/m at one end to 1600N/m at the other end. Draw S.F.D and B.M.D for the beams. Also calculate the position and magnitude of maximum bending moment.	Remember	CO 2	AAEB04.04
11	Draw the S.F.D and B.M.D for following beam  	Understand	CO 2	AAEB04.08
12	A simply supported beam 6m long is carrying a uniformly distributed load of 5KN/m over a length of 3m from the right end. Draw the S.F and B.M diagrams for the beam and also calculate the maximum B.M on the section.	Remember	CO 2	AAEB04.05
13	Derive the relation between slope, deflection and radius of curvature.	Understand	CO 2	AAEB04.06
14	Determine the deflection of a SSB with an eccentric point load.	Remember	CO 2	AAEB04.07
15	Determine the deflection of a SSB subjected to uniformly distributed load.	Understand	CO 2	AAEB04.08
16	A beam of length 5m and of uniform rectangular section is supported at its ends and carries uniformly distributed load over the entire length. Calculate the depth of the section if the maximum permissible bending stress is 8 N/mm^2 and central deflection is not to exceed 10mm.	Remember	CO 2	AAEB04.05
17	An overhanging beam ABC is loaded as shown in the figure. Find the slopes over each other and at the right end. Find also tha maximum upward deflection between the supports and the deflection at the right end. Take $E=2 \times 10^5 N/mm^2$ and $I=5 \times 10^8 N/mm^4$.	Understand	CO 2	AAEB04.06
18	A horizontal beam AB is simply supported at A and B, 6 m apart. The beam is subjected to a clockwise couple of 300 kNm at a distance of 4m from the left end as shown in the figure. If $E= 2 \times 10^5 N/mm^2$ and $I=2 \times 10^8 N/mm^4$ determine i. Deflection at the point where couple is acting and ii. The maximum deflection  	Remember	CO 2	AAEB04.07
19	A cantilever of length 2m carries a udl 2kN/m over a length of 1m from the free end, and a point load of 1kN at the free end. Find the slope and deflection at the free end if $E= 2.1 \times 10^5 N/mm^2$ and $I=6.667 \times 10^7 N/mm^4$	Understand	CO 2	AAEB04.08

20	A cantilever of length 2m carries a uniformly varying load of 25kN/m at the free end to 75kN/m at the fixed end. If E= 1 $\times10^5$ N/mm^2 and I= 10^8 N/mm^4, determine slope and deflection of the cantilever at the free end.	Remember	CO 2	AAEB04.05
Part - C (Problem Solving and Critical Thinking Questions)				
1	A beam 10m long and simply supported at each end has a uniformly distributed load of 1000N/m extending from the left end upto the centre of the beam. There is also an anti-clockwise couple of 15kN/m at a distance of 2.5m from the right end. Draw the S.F and B.M diagrams.	Remember	CO 2	AAEB04.04
2	A cantilever of length 2m carries a udl of 2KN/m run over the length of 1m from the free end. It also carries a point load of 4KN at a distance of 0.5m from the free end. Draw the S.F.D and B.M.D.	Remember	CO 2	AAEB04.04
3	A beam is loaded as shown in the figure. Draw S.F.D and B.M.D and find a) Maximum Shear Force b) Maximum Bending Moment c) Point of inflexion  	Remember	CO 2	AAEB04.03
4	Draw the sheer force and bending moment diagrams for a cantilever of length L carrying a uniformly varying load zero at free end to w per unit length at the fixed end.	Understand	CO 2	AAEB04.03
5	Draw the shear force and bending moment diagrams for a simply supported beam of length L carrying a uniformly varying load zero at each end to w per unit length at the centre.	Understand	CO 2	AAEB04.04
6	A cantilever of length 2m carries a point load of 20kN at the free end and another load of 20kN at its center. If E= 1 $\times10^5$ N/mm^2 and I= 10^8 N/mm^4 for the cantilever then determine by moment area method, the slope and deflection of the cantilever at the free end.	Understand	CO 2	AAEB04.04
7	Derive the equation of the deflection curve for a simple beam AB loaded by a couple M_0 at the left-hand support (see figure). Also, determine the maximum deflection.  	Remember	CO 2	AAEB04.03
8	A cantilever of length L carries a UDL of w per unite length of L/3 from the fixed end. Determine the slope and deflection at the free end using are moment method.	Remember	CO 2	AAEB04.04
9	A simple beam AB supports a uniform load of intensity q acting over the middle region of the span (see figure).	Understand	CO 2	AAEB04.03

	Determine the angle of rotation at the left-hand support and the deflection at the midpoint. 			
10	Determine the angle of rotation and deflection at the free end of a cantilever beam AB supporting a parabolic load defined by the equation $q = q_0x^2/L^2$ (see figure). 	Understand	CO 2	AAEB04.02
MODULE -III				
STRESSES IN BEAMS				
Part - A (Short Answer Questions)				
1	Write the equation for variation of shear stress distribution at the junction of the flange and the web.	Understand	CO 3	AAEB04.06
2	Draw the distribution of shear stress for I-Section.	Understand	CO 3	AAEB04.07
3	Draw the shear stress distribution for rectangular section	Understand	CO 3	AAEB04.06
4	Sketch the variation of shear stress for T-section.	Understand	CO 3	AAEB04.06
5	Sketch the variation of shear stress for triangular section.	Understand	CO 3	AAEB04.06
6	Sketch the variation of shear stress for rectangular section.	Remember	CO 3	AAEB04.07
7	Define the terms: bending stress, neutral axis	Remember	CO 3	AAEB04.07
8	What do you mean by simple bending?	Understand	CO 3	AAEB04.07
9	What do you mean by pure bending?	Understand	CO 3	AAEB04.08
10	What is the meaning of strength of section?	Understand	CO 3	AAEB04.07
11	Define the terms : modular ratio, equivalent section	Understand	CO 3	AAEB04.06
12	Define the terms: section modulus, filched beams.	Understand	CO 3	AAEB04.07
13	Write the Bending Equation	Understand	CO 3	AAEB04.06
14	Write the expression for Section modulus of rectangular section of width b, and depth d.	Understand	CO 3	AAEB04.06
15	Write the bending equation of a simple beam	Understand	CO 3	AAEB04.06
16	Write the expression for Section modulus of circular section having radius R.	Remember	CO 3	AAEB04.07
17	Explain the theory of simple bending	Remember	CO 3	AAEB04.07
18	What do you understand by neutral axis and moment of resistance?	Understand	CO 3	AAEB04.07
19	Write an expression for bending stress at a layer in a beam.	Understand	CO 3	AAEB04.08
20	What are the assumptions made in the theory of simple bending?	Understand	CO 3	AAEB04.07
Part - B (Long Answer Questions)				
1	A wooden beam 100mm wide, 250mm deep and 3m long is carrying a u.d.l of 40KN/m. Determine the maximum shear stress and sketch the variation of shear stress along the depth of beam.	Understand	CO 3	AAEB04.06
2	A beam of triangular cross section having base width of 100mm and height of 150mm is subjected to a shear force of 13.5KN. Find the value of maximum shear stress.	Remember	CO 3	AAEB04.07

3	A rectangular beam 80mm wide and 150mm deep is subjected to a shearing force of 30KN. Draw the distribution diagram for the shear stress.	Remember	CO 3	AAEB04.06
4	A circular beam of diameter 150mm is subjected to a shear force of 70KN. Find the value of maximum shear stress.	Understand	CO 3	AAEB04.07
5	Draw and explain shear stress distribution across I section.	Understand	CO 3	AAEB04.07
6	Show that for a rectangular section the max shear stress is 1.5 times the average stress.	Understand	CO 3	AAEB04.07
7	The shear stress is not maximum at the neutral axis in case of a triangular section. Prove this statement.	Remember	CO 3	AAEB04.06
8	A rectangular beam 100mm wide and 150mm deep is subjected to a shear force of 30kN. Determine the average stress, max shear stress	Understand	CO 3	AAEB04.07
9	Derive bending equation M/I=f/y=E/R.	Understand	CO 3	AAEB04.07
10	Discuss the assumptions involved in the theory of simple bending	Understand	CO 3	AAEB04.07
11	Derive an expression for bending stress in a layer of the beam.	Understand	CO 3	AAEB04.07
12	Explain by mathematical expression, that the shear stress abruptly changes at the junction of the flange and web of an I-section and a T- section.	Understand	CO 3	AAEB04.08
13	Draw and explain shear stress distribution across Circular section.	Understand	CO 3	AAEB04.08
14	Show that for a rectangular section, the distribution of shearing stress is parabolic.	Understand	CO 3	AAEB04.08
15	A steel plate of width 60mm and thickness 10mm is bent into a circular arc of radius 10m. Determine the max stress induced and the bending moment which will produce the max stress. Take E= $2x10^5$ N/mm^2.	Analyze	CO 3	AAEB04.07
16	Calculate the max stress induced in a cast iron pipe of external diameter 40mm of internal diameter 20mm and of length 4m when the pipe is supported at its ends and carries a point load of 80N at the centre.	Analyze	CO 3	AAEB04.07
17	A steel plate of width 60mm and of thickness 10mm is bent into a circular arc of radius 10m. Determine the maximum stress induced and the bending moment which will produce the maximum stress. Take E= $2x10^5$ N/mm^2	Analyze	CO 3	AAEB04.09
18	Show that for a rectangular section the max shear stress is 1.5 times the average stress.	Analyze	CO 3	AAEB04.07
19	A timber beam of 120mm wide and 200 mm deep and is used on a span of 4m. the beam carries a UDL of 2.8kN/m run over the entire length. Find the maximum bending stress induced.	Analyze	CO 3	AAEB04.09
20	A rectangular beam 100mm wide and 150mm deep is subjected to a shear force of 30kN. Determine the average stress, max shear stress	Analyze	CO 3	AAEB04.09
Part - C (Problem Solving and Critical Thinking Questions)				
1	The vertical post of a crane consists of an I-section 550mm×190mm. when a load of 60KN was lifted by the crane the distance of the load line from the centroid of the section is 4000mm. find the extreme stresses for the section. Take for the 550mm×190mm. area of I section = $10997mm^2$. $I_{xx}=5.316\times10^8 mm^4$	Understand	CO 3	AAEB04.05
2	A tie rod of solid circular section is subjected to a tensile force of 94.25KN at an eccentricity of 5mm from the longitudinal axis. If the maximum tensile stress is limited to $150N/mm^2$ find the minimum diameter of the rod.	Understand	CO 3	AAEB04.07
3	An I-section consists of the following sections: upper flange=130mm×50mm Web=200mm×50mm, lower	Understand	CO 3	AAEB04.07

	flange=200mm×50mm. If the beam is subjected to a shearing force of 50KN, find the maximum shear stress across the section. Also draw the shear stress distribution diagram. Take $I=284.9\times10^{6}$ mm^{4}			
4	For the section shown in the figure. Determine the average shearing stress at A, B, C & D for shearing force of 20KN. Draw the shear stress distribution. 	Remember	CO 3	AAEB04.05
5	An I-section, with rectangular ends, has the following dimensions: Flanges=150mm×20mm, Web=300mm×10mm. Find the maximum shearing stress developed in the beam for a shear force of 50KN.	Remember	CO 3	AAEB04.04
6	Prove that the moment of resistance of a beam of square section is equal to $\sigma\times x^{3}/6$ where σ is the permissible stress in bending, x is the side of the square beam and beam is placed such that its two sides are horizontal.	Remember	CO 3	AAEB04.04
7	A beam is of T-section as shown in the figure. The beam is SSB over a span of 4m and carries a UDL of 1.7kN/m run over the entire span. Determine the maximum tensile and maximum compressive stress. 	Understand	CO 3	AAEB04.07
8	A beam of an I-section shown in the figure is SSB over a span	Understand	CO 3	AAEB04.07

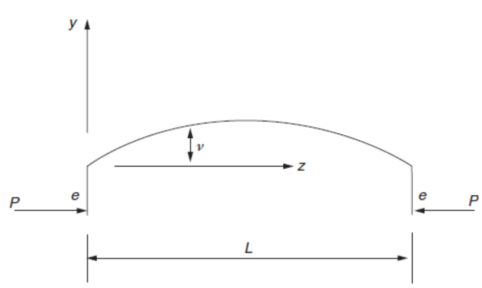
	of 4m. Determine the load that the beam can carry per meter length, if the allowable stress in the beam is 30.82N/mm^2.  			
9	A timber beam 150mm wide and 100 mm deep is to be reinforced by two steel flitches each 150mm×10mm in section. Calculate the ratio of the moments of the resistance in the two mentioned cases: i. Flitches attached symmetrically on the sides ii. Flitches attached at top and bottom.	Remember	CO 3	AAEB04.07
10	A SSB of length 4m carries a point load of 16kN at a distance of 3m from left support. The cross-section of the beam is as shown in figure. Determine the maximum tensile and compressive stress at a section which is at a distance of 2.25m from the left support.  	Remember	CO 3	AAEB04.04

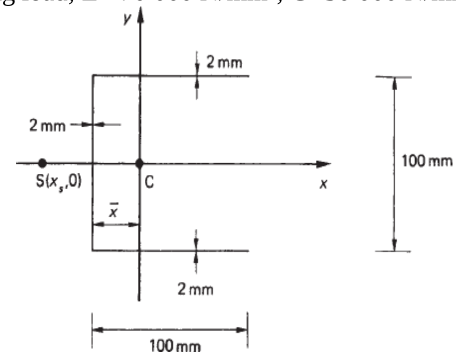
MODULE -IV

COLUMNS

Part - A (Short Answer Questions)

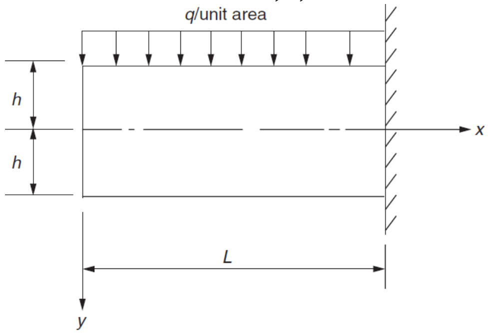
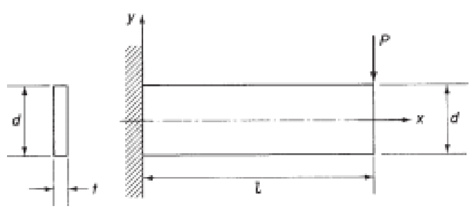
1	Write the equation of buckling load of the column subjected compressive load when both ends are hinged.	Understand	CO 4	AAEB04.08
2	Write the equation of buckling load of the column subjected compressive load when one end is fixed and other is free.	Understand	CO 4	AAEB04.08
3	Write the equation of buckling load of the column subjected compressive load when both ends are fixed.	Understand	CO 4	AAEB04.08
4	Write the equation of buckling load of the column subjected compressive load when one end is fixed and other is hinged.	Remember	CO 4	AAEB04.08
5	Write the expression for least radius of gyration and explain the terms.	Understand	CO 4	AAEB04.08

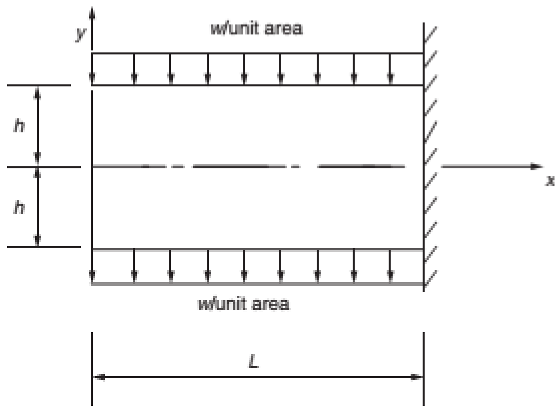
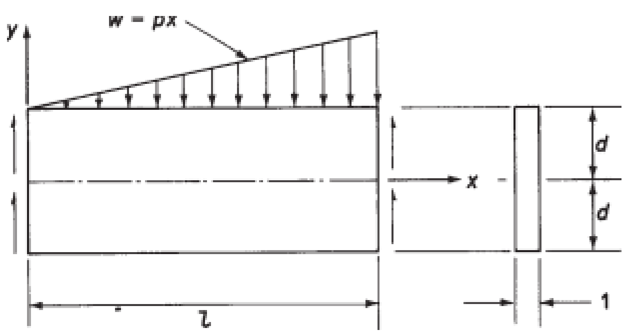
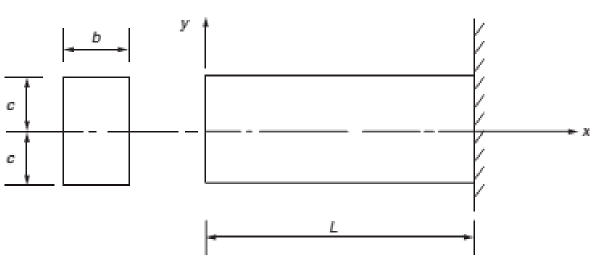
6	Write the expression for the crippling load by straight line formula.	Remember	CO 4	AAEB04.08
7	What is Johnson's parabolic formula to determine the crippling load?	Remember	CO 4	AAEB04.08
8	Define the terms column, strut, and crippling load.	Remember	CO 4	AAEB04.08
9	Explain how the failure of a short and of a long column takes place?	Remember	CO 4	AAEB04.08
10	Define buckling load.	Remember	CO 4	AAEB04.11
11	Discuss two types of instability in columns	Remember	CO 4	AAEB04.09
12	Discuss limitations of Euler's column theory.	Understand	CO 4	AAEB04.10
13	Classify types of columns with neat sketches.	Remember	CO 4	AAEB04.11
14	What are Eigen value functions and Eigen value Problems?	Understand	CO 4	AAEB04.12
15	Define Bifurcation Point for a column with neat sketches.	Remember	CO 4	AAEB04.09
16	Write a note on effective length of column. Write effective lengths for different end conditions of columns.	Understand	CO 4	AAEB04.10
17	Derive the Rankine's semi empirical formula for columns	Remember	CO 4	AAEB04.11
18	Explain failure of columns with neat sketches. Also give sign convention for bending of columns.	Understand	CO 4	AAEB04.12
19	Write the assumptions made in Euler's Column Theory	Understand	CO 4	AAEB04.10
20	Define equivalent length of a column subjected to buckling load.	Understand	CO 4	AAEB04.10
Part - B (Long Answer Questions)				
1	Discuss two types of instability in columns	Understand	CO 4	AAEB04.08
2	Discuss limitations of Euler's column theory.	Understand	CO 4	AAEB04.08
3	Classify types of columns with neat sketches.	Understand	CO 4	AAEB04.08
4	What are Eigen value functions and Eigen value Problems?	Understand	CO 4	AAEB04.10
5	Define Bifurcation Point for a column with neat sketches.	Remember	CO 4	AAEB04.08
6	Write a note on effective length of column. Write effective lengths for different end conditions of columns.	Understand	CO 4	AAEB04.08
7	Derive the Rankine's semi empirical formula for columns	Understand	CO 4	AAEB04.08
8	Explain failure of columns with neat sketches. Also give sign convention for bending of columns.	Remember	CO 4	AAEB04.08
9	Write the assumptions made in Euler's Column Theory	Understand	CO 4	AAEB04.08
10	Derive Johnson's Parabolic Formula for Short Columns	Understand	CO 4	AAEB04.08
11	Derive the expression for crippling load when one end of the column is fixed and the other end is free.	Understand	CO 4	AAEB04.09
12	Derive the expression for crippling load when one end of the column is fixed and the other end is hinged (or pinned).	Understand	CO 4	AAEB04.09
13	A strut length l, moment of inertia of cross section I uniform throughout and modulus of material E, is fixed at its lower end, and its upper end is elastically supported laterally by a spring of stiffness k. show from the first principles that the crippling load P is given by (tan α l)/(αl) = [1- (P/kL)], where α^2= (P/EI)	Understand	CO 4	AAEB04.10
14	The pin-jointed column shown in Figure carries a compressive load *P* applied eccentrically at a distance *e* from the axis of the column. Determine the maximum bending moment in the column 	Analyze	CO 4	AAEB04.10

15	A column of length 1m has the cross-section shown in Figure. If the ends of the column are pinned and free to warp, calculate its buckling load; E =70 000 N/mm^2, G=30 000 N/mm^2.  	Analyze	CO 4	AAEB04.10
16	A column of timber section 15cm×20cm is 6m long. If E=17.5KN/mm^2. Determine crippling load and safe load for the column if both ends are fixed and factor of safety is 3.	Analyze	CO 4	AAEB04.10
17	A solid round bar 3m long and 5cm in diameter is used as a strut. Determine the crippling load if a. Both ends of strut are hinged b. One end of strut is fixed and other end is free c. Both ends of strut are fixed d. One end is fixed and other is hinged	Analyze	CO 4	AAEB04.10
18	Derive the expression for maximum deflection when strut is subjected to compressive axial load with both ends pinned.	Analyze	CO 4	AAEB04.11
19	A 2m long column has a circular cross-section of 6m diameter. One of the ends of the column is fixed in direction and position and other end is free. Taking factor of safety as 3, calculate the safe load.	Analyze	CO 4	AAEB04.11
20	Deduce an expression for the Euler's crippling load of an ideal column pin-joined at each end. Explain the limitations, if any in using the formula.	Analyze	CO 4	AAEB04.11
	Part - C (Problem Solving and Critical Thinking Questions)			
1	A solid bar 4m long and 6 cm in diameter is used as a strut with both ends hinged. Determine the crippling load. Take E= 2 ×10^{5}N/mm^2	Understand	CO 4	AAEB04.12
2	A column of timber section 10cm× 15cm is 5m long both ends being fixed. If the Young's modulus for timber =17.5 kN/mm^2. Determine i. Crippling load ii. Safe load for the column if the factor of safety is 3.	Understand	CO 4	AAEB04.12
3	A hollow mild steel tube 5m long, 4cm internal diameter and 5mm thick is used as a strut with both ends hinged. Find the crippling load and safe load taking factor of safety as 3. Taking E= 2 ×10^{5}N/mm^2	Understand	CO 4	AAEB04.12
4	A short length of tube, 40mm internal and 50 mm external diameter, failed in compression at a load of 240KN. When a 2m length of the same tube was used as a strut with fixed ends, the load at failure was 158KN. Assuming that σ_C in the Rankine's formula is given by first test, find the value of constant 'a' in the same formula. Hence estimate the crippling load for a 3m long strut made out of the tube with one end fixed and other hinged.	Remember	CO 4	AAEB04.12
5	The strut of length l, moment of inertia I, of cross section I uniform throughout and modulus of material E is fixed at its	Remember	CO 4	AAEB04.12

	lower end and upper end is supported laterally by a spring of stiffness constant k. show from the first principles that the crippling load P is given by (tan α l)/(αl) = [1- (P/kL)], where α^2= (P/EI).			
6	A tubular steel strut is of 65mm external diameter and 50 mm internal diameter. It is 2.5 m long and hinged at both ends. The load acting is eccentric. Find the maximum eccentricity for a crippling load of 0.75 of the Euler load, the yield stress being 330 MPa, E = 210 GPa.	Remember	CO 4	AAEB04.13
7	Determine the crippling load for a T-section of dimensions 12cm×12cm×2cm and of length 6cm when it is used as a strut with both of its ends hinged. Take E= 2 $\times 10^5$ N/mm^2.	Understand		AAEB04.11
8	Determine Euler's crippling load for an I-section joist 30cm × 15cm ×2cm and 5m long which is used as a strut with both ends fixed. Take E= 2 $\times 10^5$ N/mm^2 for the joist.	Understand	CO 4	AAEB04.12
9	A hollow cylindrical cast iron column is 6m long with both ends fixed. Determine the minimum diameter of the column if it has to carry a safe load of 300KN with a factor of safety of 4. Take the internal diameter as 0.7 times the external diameter. Take f_c =550N/mm2 and α=1/1600 in Rankine's formula.	Understand	CO 4	AAEB04.11
10	Derive the expression for maximum deflection and maximum deflection for a strut subjected to compressive axial load or axial thrust and a transverse UDL of intensity w per unit length when both ends are pinned.	Understand	CO 4	AAEB04.10
MODULE -V				
THEORY OF ELASTISITY				
Part - A (Short Answer Questions)				
1	Define terms of principle plane and principle Stress	Understand	CO 5	AAEB04.14
2	Define the term obliquity and how it is determined	Remembering	CO 5	AAEB04.14
3	Write a note on Mohr's circle of stress	Remembering	CO 5	AAEB04.14
4	Derive the expression for the stresses on an oblique plane of a rectangular body When the body is subjected to to simple shear stress	Understand	CO 5	AAEB04.15
5	Write equations of equilibrium for elastic body under three dimensional force systems. Also draw neat sketch representing forces.	Remembering	CO 5	AAEB04.14
6	Write the equations for direct strains in terms of displacement functions for a three mutually perpendicular line elements.	Understand	CO 5	AAEB04.14
7	Derive the compatibility equation for two-dimensional problem.	Understand	CO 5	AAEB04.14
8	Write condition equations for plane stress and plane strain for 2D elastic body.	Remembering	CO 5	AAEB04.14
9	Define Airy's stress function for two dimensional problems in elasticity.	Remembering	CO 5	AAEB04.14
10	Give stress strain relationship for 2D elastic body.	Understand	CO 5	AAEB04.14
11	Derive equations of static equilibrium for a three dimensional elastic body.	Understand	CO 5	AAEB04.15
12	Derive the equations for stresses acting on inclined planes and deduce stress equations for principal planes.	Understand	CO 5	AAEB04.15
13	Determine graphically state of stress on inclined plane for a deformable body.	Understand	CO 5	AAEB04.14
14	Derive the strain equations for three mutually perpendicular line elements in terms of displacement functions and deduce compatibility equations.	Understand	CO 5	AAEB04.15
15	Write the expression for normal and tangential stress on a oblique plane when a member is subjected to a simple shear stress τ.	Understand	CO 5	AAEB04.14

16	Write the expression for major principal stress for a member is subjected to two direct stresses in two mutually perpendicular directions are accompanied by a simple shear stress.	Understand	CO 5	AAEB04.14
17	Write the expression for minor principal stress for a member is subjected to two direct stresses in two mutually perpendicular directions are accompanied by a simple shear stress.	Understand	CO 5	AAEB04.15
18	Write the expression for maximum shear stress for a member is subjected to two direct stresses in two mutually perpendicular directions are accompanied by a simple shear stress.	Understand	CO 5	AAEB04.16
19	At what angle the maximum and minimum normal stresses act to each other.	Understand	CO 5	AAEB04.16
20	What is the condition of maximum shear stress for a member is subjected to two direct stresses in two mutually perpendicular directions are accompanied by a simple shear stress.	Understand	CO 5	AAEB04.16
Part - B (Long Answer Questions)				
1	Derive equations of static equilibrium for a three dimensional elastic body.	Understand	CO 5	AAEB04.17
2	Derive the equations for stresses acting on inclined planes and deduce stress equations for principal planes.	Understand	CO 5	AAEB04.17
3	Determine graphically state of stress on inclined plane for a deformable body.	Understand	CO 5	AAEB04.17
4	Derive the strain equations for three mutually perpendicular line elements in terms of displacement functions and deduce compatibility equations.	Understand	CO 5	AAEB04.14
5	Derive equations for stains on inclined planes and deduce strain for principal planes.	Understand	CO 5	AAEB04.14
6	Draw the Mohr's Circle to determine strains on inclined plane.	Remembering	CO 5	AAEB04.15
7	A structural member supports loads which produce, at a particular point, a direct tensile stress of $80N/mm^2$ and a shear stress of $45N/mm^2$ on the same plane calculate the values and directions Of the principal stresses at the point and also the maximum stress, stating on which planes this will act.	Remembering	CO 5	AAEB04.15
8	A solid shaft of circular cross-section supports a torque of 50KNm and a bending moment of 25KNm. If the diameter of the shaft is 150mm calculate the values of the principal stresses and their directions at a point on the surface of the shaft?	Understand	CO 5	AAEB04.14
9	A shear stress τ_{xy} acts in a two-dimensional field in which the maximum allowable shear stress is denoted by τ_{max} and the major principal stress by σ_1. Derive using the geometry of Mohr's circle of stress, expressions for the maximum values of direct stress which may be applied to the x and y planes in terms of three parameters given above.	Understand	CO 5	AAEB04.14
10	The stresses at point of a machine component are 150MPa and 50MPa both tensile. Find the intensities of normal, shear and resultant stresses on a plane inclined at an angle of 55 with axis of major tensile stress. Also find the magnitude of the maximum shear stress in the component.	Understand	CO 5	AAEB04.17
11	A bar is subjected to a tensile stress of 100MPa, determine the normal and tangential stresses on a plane making an angle of 30^o with the direction of the tensile stress.	Analyze	CO 5	AAEB04.17
12	Write the expression for major and minor principal stresses for an oblique plane subjected to direct stress in two mutually perpendicular directions and accompanied with shear stress.	Analyze	CO 5	AAEB04.17
13	The principal stresses or a point in the section of a member are 50MPa or 20MPa both tensile. If there is a clockwise shear stress of 30MPa, find the normal and shear stresses on a section inclined at an angle of 15^o with the normal to the major tensile stress.	Analyze	CO 5	AAEB04.17

14	A cantilever of length L and depth 2h is in a state of plane stress. The cantilever is of unit thickness, is rigidly supported at the end x=L and is located as shown in figure. Show that stress function $\phi = Ax^2+Bx^2y+Cy^3+D(5x^2y^3-y^5)$ is valid for the beam and evaluate the constants A,B,C and D. 	Analyze	CO 5	AAEB04.17
15	The principal stresses at a point in the section of a member are 50MPa and 20MPa both tensile. If there is a clockwise shear of 30MPa, find graphically the normal and shear stresses on a section inclined at an angle of 15^o with the normal to the major tensile stress.	Analyze	CO 5	AAEB04.17
16	A point in the stressed element, the normal stresses in two mutually perpendicular directions are45MPa and 25MPa both tensile. The complimentary shear stress in these directions is 15MPa. By using Mohr's circle method determine the maximum and minimum principal stresses.	Analyze	CO 5	AAEB04.17
17	A plane element in a boiler is subjected to tensile stresses of 400MPa on one plane and 150MPa on the other	Analyze	CO 5	AAEB04.17
18	A rectangular bar of cross-sectional are 1200 mm^2 is subjected to an axial load of 360 N/mm^2. Determine the normal and shear stresses on a section which is inclined at an angle of 30 with the normal cross-section of the bar.	Analyze	CO 5	AAEB04.17
19	Find the diameter of a circular bar which is subjected to an axial pull of 150kN, if the maximum allowable shear stress on any section is 60N/ mm^2.	Analyze	CO 5	AAEB04.17
20	What do you understand by an Airy stress function in two dimensions? A beam of length *l*, with a thin rectangular cross-section, is built-in at the end $x = 0$ and loaded at the tip by a vertical force *P* . Show that the stress distribution, as calculated by simple beam theory, can be represented by the expression $\varphi = Ay3 + By3x + Cyx$ as an Airy stress function and determine the coefficients *A*, *B* and *C.* 	Analyze	CO 5	AAEB04.17
Part - C (Problem Solving and Critical Thinking Questions)				
1	The cantilever beam shown in Figure is in a state of plane strain and is rigidly supported at $x = L$. Examine the following stress function in relation to this problem: $\varphi = (w/20h^3)\ (15h^2x^2y - 5x^2y^3 - 2h^2y^3 + y^5)$ Show that the stresses acting on the boundaries satisfy the	Understand	CO 5	AAEB04.17

	conditions except for a distributed direct stress at the free end of the beam which exerts no resultant force or bending moment. 			
2	A thin rectangular plate of unit thickness is loaded along the edge $y = +d$ by a linearly varying distributed load of intensity $w = px$ with corresponding equilibrating shears along the vertical edges at $x = 0$ and l. As a solution to the stress analysis problem an Airy stress function φ is proposed, where $\varphi = (p/120d^3)\,[5(x^3 - l^2x)(y + d)^2(y - 2d) - 3yx(y^2 - d^2)^2]$. Show that φ satisfies the internal compatibility conditions and obtain the distribution of stresses within the plate. Determine also the extent to which the static boundary conditions are satisfied. 	Understand	CO 5	AAEB04.17
3	The cantilever beam shown in Fig. P.2.5 is rigidly fixed at $x = L$ and carries loading such that the Airy stress function relating to the problem is $\varphi = (w/40bc^3)\,(-10c^3x^2 - 15c^2x^2y + 2c^2y^3 + 5x^2y^3 - y^5)$ Find the loading pattern corresponding to the function and check its validity with respect to the boundary conditions. 	Understand	CO 5	AAEB04.17

4	Show that the compatibility equation for the case of plane strain, viz. $$\frac{\partial^2 \gamma_{xy}}{\partial x \partial y} = \frac{\partial^2 \varepsilon_y}{\partial x^2} + \frac{\partial^2 \varepsilon_x}{\partial y^2}$$ may be expressed in terms of direct stresses σ_x and σ_y in the form $$\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)(\sigma_x + \sigma_y) = 0$$	Remembering	CO 5	AAEB04.16
5	The principal tensile stress at a point across two mutually perpendicular planes is 100N/mm^2 and 50 N/mm^2. Determine the normal, tangential and resultant stresses on a plane inclined at 30^0 to the axis of the minor principal stress.	Understand	CO 5	AAEB04.16
6	At a point in a strained material, the principal stresses are 140 N/mm^2(tensile) and 60N/mm^2(compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 45^0 to the axis of the major principal stress. What is the maximum intensity of shear stress in the material at the point?	Understand	CO 5	AAEB04.15
7	At a point in a two dimensional system, the normal stress on two mutually perpendicular planes are σ_1 and σ_2 (both alike) and shear stress is τ. Show that one of the principal stresses is zero if $\tau=\sqrt{\sigma_1 \times \sigma_2}$.	Remembering	CO 5	AAEB04.14
8	A rectangular block of material is subjected to a tensile stress of 100 N/mm2 on one plane and a tensile stress of 50N/mm2 on a plane at right angles, together with shear stresses of 60N/mm2 on the faces. Find: i. The direction of principal planes ii. The magnitude of principal stresses and iii. Magnitude of the greatest shear stress.	Understand	CO 5	AAEB04.14
9	A strained material is subjected to two dimensional stresses. Prove that the sum of the normal components of stresses on any two mutually perpendicular planes is constant.	Understand	CO 5	AAEB04.14
10	The principal tensile stresses at a point across two mutually perpendicular planes are 100N/mm^2 and 50N/mm^2. Determine the normal and tangential and resultant stresses on a plane inclined at 300 to the axis of the minor principal stress. Use Mohr's circle method.	Understand	CO 5	AAEB04.14

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