INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

ASSIGNMENT

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
Course Faculty	:	Dr. Akshay S. K. Naidu

OBJECTIVES

The objective of the course is to impart knowledge and abilities to the students to:

I. **Relate** mechanical properties of a material with its behavior 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 Outcome
	UNIT-I SIMPLE STRESSES AND STRAINS – STRAIN ENERGY		
1.	Define and explain types of stresses. Derive an expression for Young's modulus in terms of bulk modulus and Poisson's ratio.	Understanding & remembering	1,2
2	Define resilience, proof resilience and modulus of resilience. Prove that maximum strain energy stored in a body is given by $U = \frac{\sigma^2}{2E} \times$ volume	Apply & evaluate	1,2
3	Define (i) longitudinal strain and lateral strain (ii) Poisson's ratio and factor of safety (iii) volumetric strain.	Understanding & remembering	1,2
4	Define strain energy, spring and impact loading. Prove that the strain energy stored in a body due to when the load is applied suddenly is given by $\sigma = 2 \times \frac{P}{A}$	Apply & evaluate	1,2
5	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 2.1×10^5 N/mm^2.	Apply & evaluate	1,2,3

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	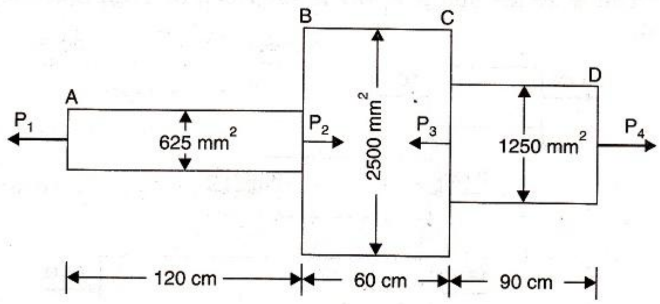		
6	A compound tube consists of a steel tube 140mm internal diameter and 160mm external diameter and an outer brass tube 160mm internal diameter and 180mm external diameter. The two tubes are of the same length. The compound tube carries an axial load of 900kN. Find the stresses and the load carried by 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.	Apply & evaluate	1,2,3
7	A steel rod of 3cm diameter and 5m long is connected to two grips and the rod is maintained at a temperature of 95^{o}C. Determine the stress and pull exerted when the temperature falls to 30^{o}C, if (i) the ends do not yield, and (ii) the ends yield by 0.12cm. Take E = $2x10^5$ MN/m^2 and α = $12x10^{-6}$/^{o}C.	Apply & evaluate	1,2,3
8	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.	Apply & 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 $$U = \frac{A\,\rho^2\,L^3}{6E}$$	Apply & evaluate	1,2
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.	Apply & evaluate	1,2,3
	UNIT-II **SHEAR FORCE AND BENDING MOMENT**		
1	What are the different types of loads? Differentiate between point load and uniformly distributed load.	Understanding & remembering	2,4
2	What do you mean by point of contraflexure? Is point of contraflexure and point of inflexion different?	Understanding & remembering	2,4
3	Explain 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	2,4
4	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.	analyze & Apply	2,4

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5	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.	Apply & evaluate	2,4
6	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.	Apply & evaluate	2,4
7	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.	Apply & evaluate	2,4
8	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.	Apply & evaluate	2,4
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.	Apply & evaluate	2,4
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.	Apply & evaluate	2,4
UNIT-III FLEXURAL STRESSES - SHEAR STRESSES			
1	Explain theory of simple bending with assumptions.	Understanding	5
2	Derive an expression for bending stress of a section.	analyze & Apply	5
3	Show that for a rectangular section of the maximum shear stress is 1.5 times the average stress.	analyze & Apply	5
4	Derive the expression $\frac{\sigma_1}{E_1} = \frac{\sigma_2}{E_2}$	analyze & Apply	5
5	Prove that the shear stress distribution in a rectangular section of beam which is subjected to a shear force F is given by $\tau = \frac{F}{2I}(\frac{d^2}{4} - y^2)$	analyze & Apply	5
6	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?	Apply & evaluate	5, 6

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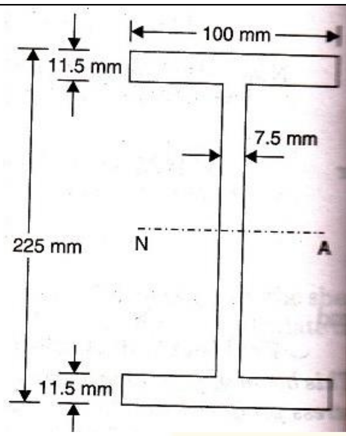
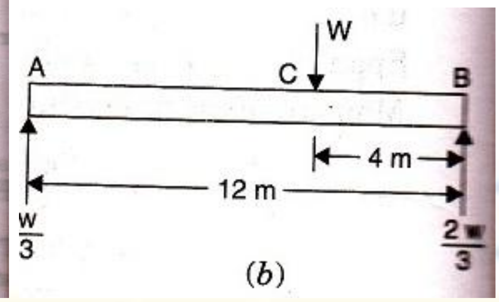
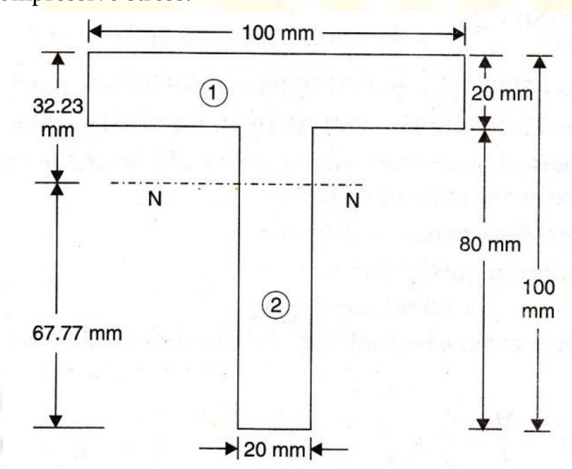
	 		
7	A cast iron beam is of T-section as shown in figure. The beam is simply supported on a span of 8m. The beam carries a uniformly distributed load of 1.5kN?m length on the entire span. Determine the maximum tensile and maximum compressive stress. 	Apply & evaluate	5, 6
8	A timber beam of rectangular 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.	Apply & evaluate	5, 6
9	A circular beam of 100mm 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.	Apply & evaluate	5, 6
10.	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.	Apply & evaluate	5, 6
	UNIT-1V **PRINCIPAL STRESSES AND STRAINS – THEORIES OF FAILURE**		
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	analyze & Apply	7, 8
2	A rectangular bar is subjected to two direct stresses σ_1 and σ_2 in two mutually	analyze &	7, 8

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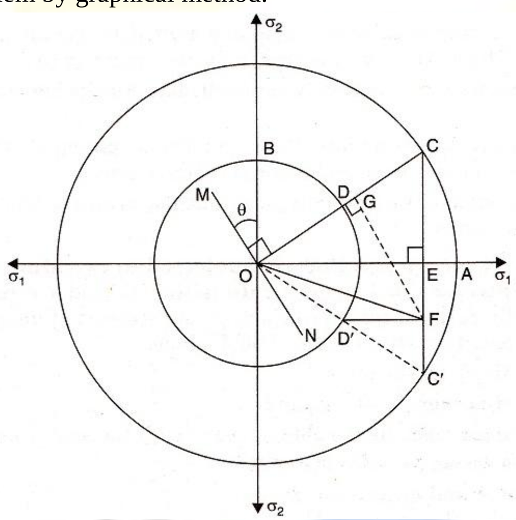
	perpendicular directions. Prove that the normal stress and shear stress on an oblique plane which is inclined at an angle θ with the axis of minor stress are given by $\sigma_n = \frac{\sigma_1+\sigma_2}{2} + \frac{\sigma_1-\sigma_2}{2} cos2\theta$ and $\sigma_t = \frac{\sigma_1-\sigma_2}{2} sin2\theta$	Apply	
3	Define principal stress, obliquity. Write short notes on Mohr’s circle of stresses. State distortion energy theorem for failure.	Understanding & remembering	7, 8, 9
4	Define and explain he theories of failure: (i) Maximum principal stress theory (ii) Maximum principal strain theory	Understanding	7, 8, 9
5	Define and explain he theories of failure: (i) Maximum shear stress theory (ii) Maximum shear strain energy theory	Understanding	7, 8, 9
6	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.	Apply & evaluate	7,8,9
7	Solve the problem by graphical method. 	Apply & evaluate	7, 8
8	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

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	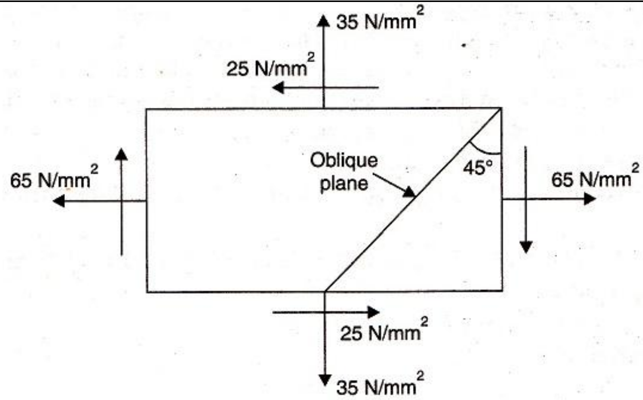		
9	The principal stresses at a point in a elastic material are 22 N/mm^2 (tensile), 110N/mm^2 (tensile) and 55 N/mm^2 (compressive). If the elastic limit in simpletension is 220 N/mm^2 and μ = 0.3, then determine whether the failure of material will occur or not according to (i) Maximum principal stress theory (ii) Maximum principal strain theory (iii) Maximum shear stress theory (iv) Maximum strain energy theorem (v) Maximum shear strain energy theory	Apply & 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.	Apply & evaluate	7,8,9
UNIT-V **DEFLECTION OF BEAMS – CONJUGATE BEAM METHOD**			
1	Define deflection and slope. What is Macaulay's method? Where is it used? What is moment area method? Where is it used?	Remembering & Understanding	10
2	What is the use of conjugate beam method over other methods? How will you use conjugate beam method for finding slope and deflection at any section of a given beam? What is the relation between an actual beam and the corresponding conjugate beam for different end conditions?	Remembering & Understanding	10
3	Derive an expression for slope and deflection of a beam subjected to uniform bending moment.	analyze & Apply	10
4	Prove that the relation $M = EI\frac{d^2y}{dx^2}$ where M is Bending moment and E is modulus of elasticity and I is moment of inertia.	analyze & Apply	10
5	Derive slope and deflection of a cantilever carrying a gradually varying load from zero at the free end to w/m run at the fixed end.	analyze & Apply	10
6	A cantilever carries a point load at the free end. Determine the deflection at free end using conjugate beam method.	analyze & Apply	10
7	A beam of length 8m is simply supported at is ends. It carries a uniformly	Apply &	10

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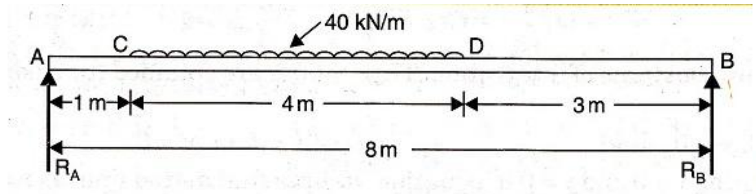
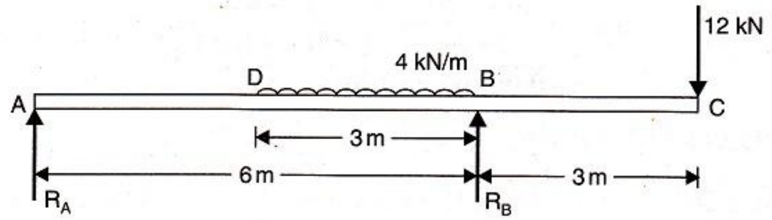
	distributed load of 40kN/m as shown in figure below. Determine the deflection of the beam at its midpoint and also the position of maximum deflection and maximum deflection. Take E = 2 x 10^5 N/mm^2 and I = 4.3 x 10^8 mm^4. 	Evaluate	
8	A beam ABC of length 9m has one support to the left end and the 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
9	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
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

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