INSTITUTEOFAERONAUTICALENGINEERING

(Autonomous)

Dundigal,Hyderabad-500043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**STRENGTH OF MATERIALS - I**
Course Code	:	**ACE001**
Class	:	B. Tech III Semester
Branch	:	CE
Year	:	2018-19
Course Coordinator	:	Dr. Venu M, Professor, Department of Civil Engineering
Course Faculty	:	Dr. Venu M, Professor, Department of Civil Engineering Mr. Anand Goud , Asst.Professor, Department of Civil Engineering

COURSE OBJECTIVES:

The course should enable the students to:

I	Relate mechanical properties of a material with its behavior under various load types
II	Apply the concepts of mechanics to find the stresses at a point in a material of a structural member.
III	Analyze a loaded structural member for deflections and failure strength.
IV	Evaluate the stresses and strains in materials and deflections in beam members.

COURSELEARNING OUTCOMES:

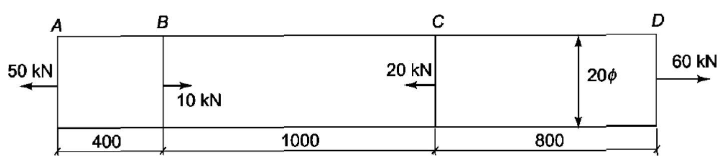
Students, who complete the course, will have demonstrated the ability to do the following:

CACE001.01	Calculate the stress and strain developed in any structural member due to applied external load.
CACE001.02	Calculate the normal and tangential stresses on an inclined section a bar of under uni-axial, biaxial, pure shear and plain stress conditions.
CACE001.03	Predict the strain energy and their applications like sudden load, uniform load and impact load.
CACE001.04	Evaluate the principal stress and principal strain at a point of a stressed member and draw the Mohr's circle of stresses.
CACE001.05	Understand failure of a material using various theories of failure, and their relative applications.
CACE001.06	Differentiate the types of beam and the various loading and support condition upon them.
CACE001.07	Apply the formulae for beams under different loading condition.
CACE001.08	Draw shear force diagram and bending moment diagram for different type of beams.
CACE001.09	Derive the pure bending equation, and on its basis explain the existence of normal stresses.
CACE001.10	Analyze the pure bending equation and on its basis.
CACE001.11	Explain the existence of shear stresses in the different layers of the beam.
CACE001.12	Evaluate the section modulus for various beam cross-sections.
CACE001.13	Explain the importance of section modulus for various beam cross-sections.
CACE001.14	Derive the torsion equations and pure torsion.
CACE001.15	Explain the design procedures of shafts and their theories of failure applications.
CACE001.16	Understand the types of springs and explain their different conditions.
CACE001.17	Analyze the close and open coiled helical springs under various CACE001.nditions.
CACE001.18	Differentiate the types of column under the various end CACE001.nditions.
CACE001.19	Analyze the columns under the various formulas like Euler's formulae, Rankie's and Gordon formula.
CACE001.20	Calculate the columns under the various formulas like empirical formulae, straight line formula and Perry's formula.

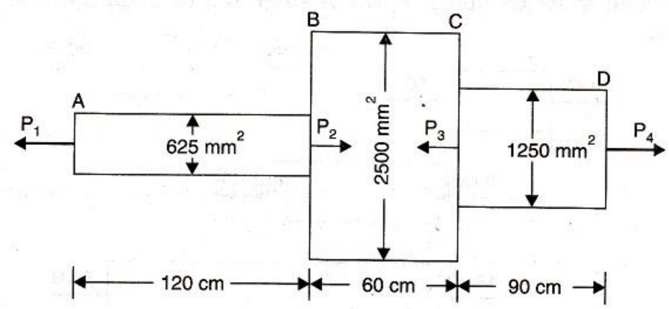
CACE001.21	Understand the laterally loaded struts under concentrated and uniformly distributed loads.
CACE001.22	Calculate the laterally loaded struts under various loading conditions.
CACE001.23	Possess the Knowledge and Skills for employability and to succeed in national and international level competitive examinations.

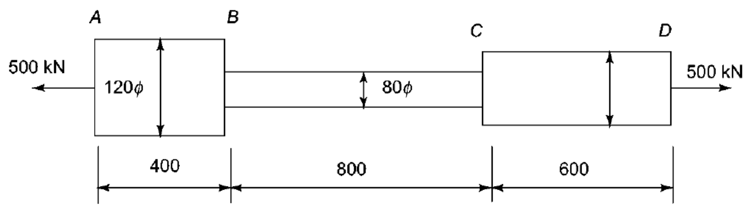
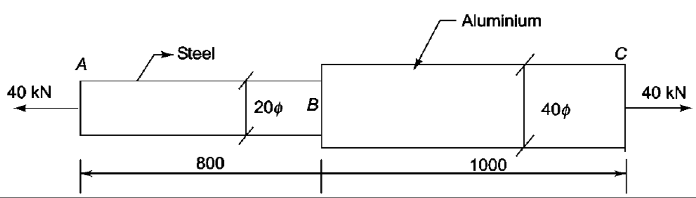
TUTORIAL QUESTION BANK

S.No.	QUESTIONS	Blooms Taxonomy Level	Course Learning Outcomes
UNIT - I			
SIMPLE STRESSES AND STRAINS, STRAIN ENERGY			
Part - A (Short Answer Questions)			
1	Distinguish between the terms Elasticity and Plasticity with examples.	Remember	CACE001.2
2	Define the following properties of engineering materials: Ductility, Brittleness andMalleability.	Remember	CACE001.2
3	Define the following properties of engineering materials: Toughness, Hardness and Strength.	Remember	CACE001.2
4	Define Stress at a point in a material, and mention its units.	Remember	CACE001.2
5	Distinguish between different types of stress using illustrations	Remember	CACE001.2
6	Define Strain in a material and give its units.	Remember	CACE001.2
7	State Hooke's law and give its equation.	Remember	CACE001.2
8	Distinguish between different types of strain	Remember	CACE001.2
9	Define modulus of elasticity and give its units.	Remember	CACE001.2
10	Draw stress-strain diagram for mild steel indicating all critical points.	Understand	CACE001.2
11	Define longitudinal strain and lateral strain.	Remember	CACE001.3
12	Define Poisson's ratio and its range of values.	Remember	CACE001.4
13	Define Volumetric strain and bulk modulus	Remember	CACE001.2
14	Give the relationship between Young's modulus, Rigidity Modulus and Bulk Modulus.	Remember	CACE001.3
15	Define rigidity modulus and give its units.	Remember	CACE001.3
16	What is meant by strain energy?	Understand	CACE001.3
17	Distinguish between modulus of resilience and modulus of toughness.	Understand	CACE001.2
18	Define resilience and proof resilience.	Understand	CACE001.3
19	What is working stress?	Understand	CACE001.3
20	Define factor of safety and state why it is used?	Understand	CACE001.2
Part - B (Long Answer Questions)			
1	Explain with illustrations and stress-strain diagrams, the phenomenon of strain-hardening.	Understand	CACE001.3
2	Explain with illustrations and stress-strain diagrams, the phenomenon of necking.	Understand	CACE001.2

3	A tensile test was conducted on a mild steel bar. The following data was obtained from the test: Diameter of steel bar = 4cm; Gauge length of the bar = 25cm Load at elastic limit = 200kN; Extension at load of 160kN = 0.19mm Maximum load = 350kN; Determine: (a) Young's modulus (b) Yield strength (c) Ultimate Strength (d) Strain at the elastic limit	Remember	CACE001.3
4	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	Understand	CACE001.3
5	A bar of uniform cross section 20 mm diameter is subjected to loads as shown in Fig. Find the total elongation of the bar and the maximum stress in the bar. E = 200 GPa. (All lengths are in mm.) 	Understand	CACE001.2
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	Remember	CACE001.2
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	Remember	CACE001.1
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.	Understand	CACE001.2
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),	Remember	CACE001.3
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.	Remember	CACE001.3

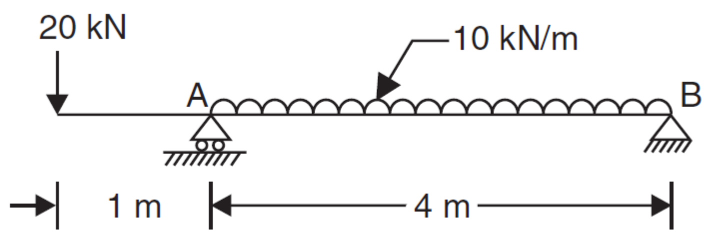
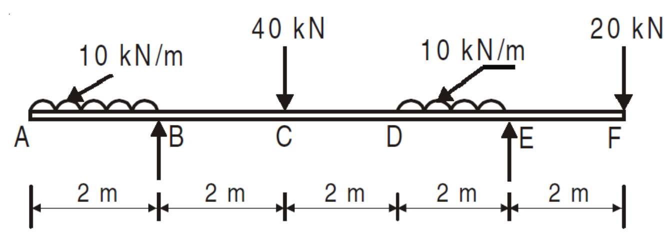
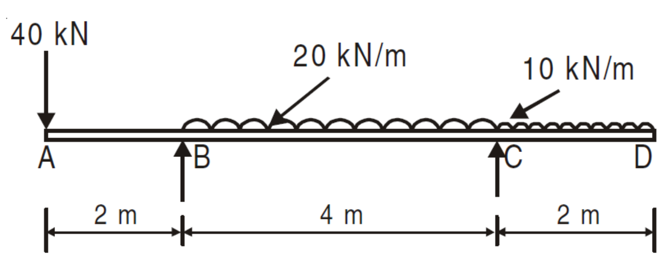
11	A 2.0 m long steel tie bar is subjected to force of 150 kN. Determine its cross-section so that (i) the stress does not exceed 140 MPa (ii) the extension is not more than 1.2 mm. Assume Young's modulus of 210 GPa. If steel bars are available in increments of 5 mm from 30 mm diameter onwards, choose the appropriate diameter for both cases.	Understand	CACE001.2
12	A tensile test was conducted on a mild steel bar. The following data was obtained from the test: Diameter of steel bar = 5cm; Gauge length of the bar = 30cm Load at elastic limit = 250kN; Extension at load of 200kN 0.25mm Maximum load = 420kN; Determine: (a) Young's modulus (b) Yield strength (c) Ultimate Strength (d) Strain at the elastic limit	Remember	CACE001.2
13	Derive the constitutive relationship between stress and strain for three dimensional stress systems.	Remember	CACE001.2
14	A tensile test was conducted on a mild steel bar. The following data was obtained from the test: Diameter of steel bar = 2.5cm; Gauge length of the bar = 25cm Load at elastic limit = 275kN; Extension at load of 120kN = 0.21mm Maximum load = 380kN; Determine: (a) Young's modulus (b) Yield strength (c) Ultimate Strength (d) Strain at the elastic limit	Understand	CACE001.2
15	A 2.5 m long steel tie bar is subjected to force of 125 kN. Determine its cross-section so that (i) the stress does not exceed 130 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.	Understand	CACE001.5
16	Derive relationships between Young's modulus, rigidity modulus and bulk modulus, including Poisson's ratio into the relationships.	Understand	CACE001.5
17	Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is 1.2×10^5 N/mm^2 and modulus of rigidity is 4.5×10^4 N/mm^2	Understand	CACE001.2
18	A steel bar of 25 mm diameter is tested in tension and following is observed: Limit of Proportionality = 180kN; Load at yield = 210kN, Ultimate load = 275kN. Compute the stresses in the specimen at various stages. If the factor of safety is 1.75, determine the permissible stress in the material.	Understand	CACE001.5
19	Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is 1.5×10^5 N/mm^2 and modulus of rigidity is 4.8×10^4 N/mm^2	Understand	CACE001.2
20	A bar of 100mm in diameter was subjected to tensile load of 70kN and the measured extension on 320mm gauge length was 0.115mm and change in diameter was 0.0034mm. Calculate the Poisson's ratio and three Moduli.	Understand	CACE001.2
Part - C (Problem Solving and Critical Thinking Questions)			

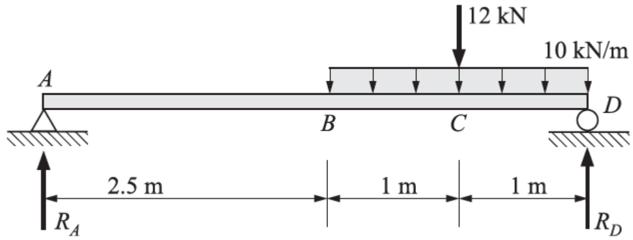
1	A tensile test was conducted on a mild steel bar. The following data was obtained from the test: Diameter of steel bar = 3 cm Gauge length of the bar = 20 cm Load at elastic limit = 250 kN Extension at load of 150 kN = 0.21 mm Maximum load = 380 kN Total extension = 60 mm Diameter of rod at failure = 2.25 cm Determine: (a) Young's modulus (b) stress at elastic limit (c) percentage elongation (d) percentage decrease in area	Understand	CACE001.1, CACE001.2
2	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. 	Understand	CACE001.2, CACE001.3
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 2×10^5 N/mm^2 and for brass as 1×10^5 N/mm^2.	Understand	CACE001.2, CACE001.3
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^{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 = 2×10^5 MN/m^2 and $\alpha = 12 \times 10^{-6}/^oC$.	Understand	CACE001.3
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.	Understand	CACE001.2, CACE001.3
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= 2×10^5 N/mm^2 and Poisson's ratio = 0.30.	Understand	CACE001.2, CACE001.3
7	Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is 1.2×10^5 N/mm^2 and modulus of rigidity is 4.5×10^4 N/mm^2	Understand	CACE001.2, CACE001.3
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 Moduli.	Understand	CACE001.2, CACE001.3

9	A bar has three sections of different diameters, 120 mm, 80 mm, and 100 mm, and is subjected to a load of 500 kN as shown in Fig. Find the total elongation of the bar and the maximum stress in the material. E = 200,000 MPa. 	Understand	CACE001.2, CACE001.3
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.	Understand	CACE001.4, CACE001.5
11	A steel rod, 20 mm diameter and 800 m long, is rigidly attached to an aluminium rod, 40 mm diameter and1 m long, as shown in Fig. 3.7. The combination is subjected to a tensile load of 40 kN. Find the stress in the materials and the total elongation of the bar. E for steel = 200 GPa, E for aluminium = 70 GPa. 	Understand	CACE001.4
12	A bar of 20mm in diameter was subjected to tensile load of 45kN and the measured extension on 200mm gauge length was 0.11mm and change in diameter was 0.0036mm. Calculate the Poisson's ratio and three Moduli.	Understand	CACE001.4
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 moduli of steel and concrete is 12.5?	Understand	CACE001.4
14	A tensile load of 80kNis applied to a bar of 120mm in diameter and the measured extension on 400mm gauge length was 0.122mm and change in diameter was 0.0046mm. Calculate the Poisson's ratio and three Moduli.	Understand	CACE001.3
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 ends 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?	Understand	CACE001.4

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 ends 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?	Understand	CACE001.4
17	A compound bar comprises of a 12.5 mm diameter aluminium rod and a copper tube of inner diameter 14.5 mm and outer diameter 25 mm. If the Young's modulli of aluminium 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 aluminium and α = 16.8 x 10^{-6} per K for copper.	Understand	CACE001.4
18	Compute the strain energy in a steel bar (E = 200 GPa) of length 2.5 m and 20 mm diameter under a load of 45 kN. What is the resilience modulus of the bar, if the yield stress is 240 MPa?	Understand	CACE001.5
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.	Understand	CACE001.5
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?	Understand	CACE001.5
UNIT - II			
SHEAR FORCE AND BENDING MOMENT			
Part – A (Short Answer Questions)			
1	What are the different types of beams?	Remember	CACE001.6
2	Differentiate between a simply supported beam and a cantilever.	Understand	CACE001.6
3	Differentiate between a fixed beam and a cantilever.	Understand	CACE001.7
4	Show by proper diagram, positive and negative shear forces at a section of a beam.	Remember	CACE001.7
5	Draw shear force diagrams for a cantilever of length L carrying a point load W at the free end.	Understand	CACE001.8
6	Draw shear force diagrams for a cantilever of length L carrying a point load W at the mid-span.	Understand	CACE001.8
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.	Understand	CACE001.8
8	Draw shear force diagrams for a simply supported beam of length L carrying a point load W at its mid-span.	Understand	CACE001.7
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.	Understand	CACE001.8
10	Explain what information we obtain from shear force diagram and bending moment diagram.	Understand	CACE001.7
11	Draw bending moment diagrams for a cantilever of length L carrying a point load W at the free end.	Understand	CACE001.6
12	Draw bending moment diagram for a cantilever of length L carrying a point load W at the mid-span.	Understand	CACE001.6
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.	Understand	CACE001.7

14	Draw bending moment diagram for a simply supported beam of length L carrying a point load W at its mid-span.	Understand	CACE001.7
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.	Understand	CACE001.8
16	Draw bending moment diagram for a cantilever beam of length L with a positive moment M applied at its free end.	Understand	CACE001.8
17	Draw bending moment diagram for a simply supported beam of length L with an anti-clockwise moment M applied at the mid-span.	Understand	CACE001.8
18	Give the mathematical relationship between rate of loading, shear force and bending moment at a section in a beam.	Remember	CACE001.6
19	What do you mean by point of contraflexure?	Understand	CACE001.7
20	How many points of contraflexure you will have for simply supported beam overhanging at one end. Explain with a neat sketch.	Understand	CACE001.7
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.	Understand	CACE001.6
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.	Understand	CACE001.7
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.6
6	A cantilever beam AB (A-fixed and B free) of length 4m, having UDL 2kN/m in the right half span, Draw SFD and BMD.	Understand	CACE001.7
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.6
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.	Understand	CACE001.7

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.	Understand	CACE001.7
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.	Understand	CACE001.7
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.	Understand	CACE001.8
16	An overhanging beam is on rollers at *A* and is hinged at *B* and is loaded as shown in Figure. Determine the reactions at *A* and *B*. Draw SFD and BMD 	Understand	CACE001.6
17	A beam of ABCDEF as shown in fig. Find the maximum bending positive bending moment and maximum negative bending moment. 	Understand	CACE001.7
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.	Understand	CACE001.8
19	The loading on an overhanging beam is shown in figure. Draw the SFD and BMD. 	Understand	CACE001.8

20.	A simply supported beam having different loading as shown in figure. Draw the SFD and BMD 	Understand	CACE001.8
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.6
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.	Understand	CACE001.7
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.6
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.8
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.	Understand	CACE001.8

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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.6
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.	Understand	CACE001.7
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.	Understand	CACE001.8
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.	Understand	CACE001.6
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.	Understand	CACE001.7

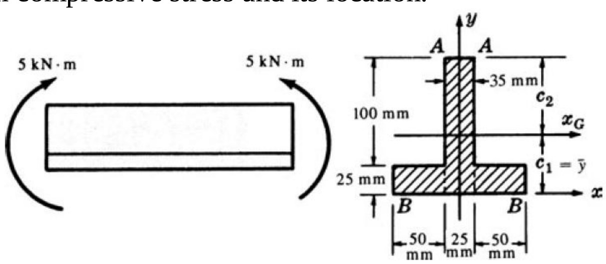
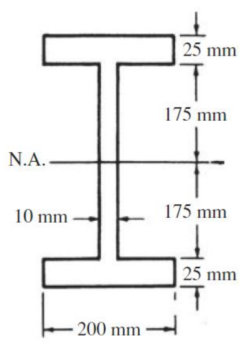
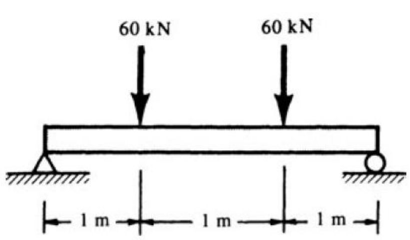
UNIT-III

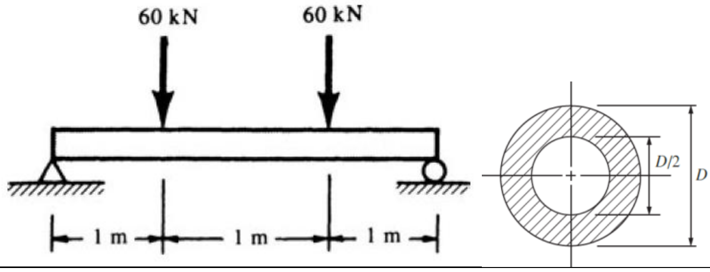
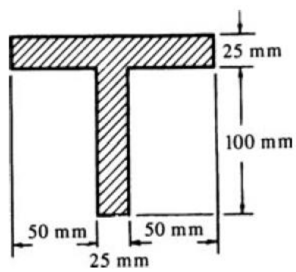
FLEXURAL STRESSES, SHEAR STRESSES

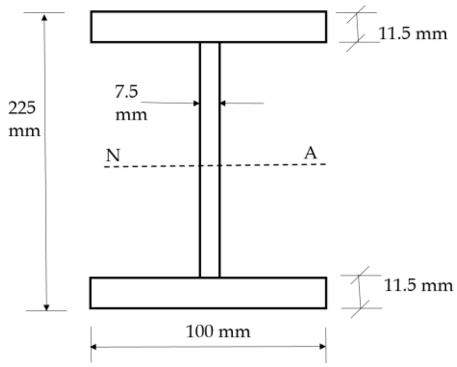
Part - A (Short Answer Questions)

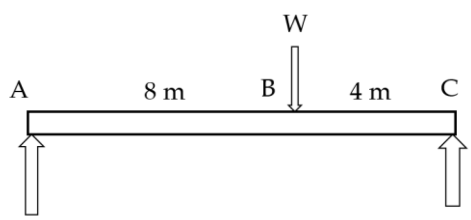
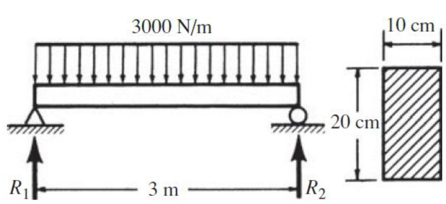
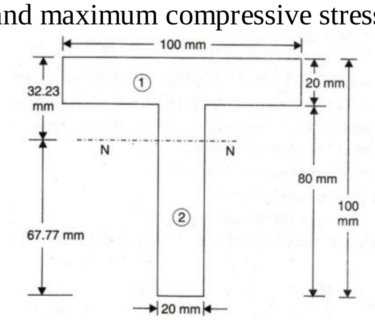
1	Define bending stress in a beam with a diagram.	Remember	CACE001.9
2	Define pure bending and show an example by a figure.	Remember	CACE001.9
3	Define neutral axis and where is it located in a beam.	Remember	CACE001.9
4	What are the assumptions made in theory of simple bending?	Understand	CACE001.10
5	Write the bending equation, defining all the terms in the equation.	Understand	CACE001.11
6	Explain the terms: moment of resistance and section modulus	Understand	CACE001.10
7	Explain the role of section modulus in defining the strength of a section.	Understand	CACE001.10
8	Write the section modulus for a solid rectangular section.	Understand	CACE001.11
9	Write the section modulus for a hollow rectangular section.	Understand	CACE001.11
10	Write the section modulus for a solid circular section.	Understand	CACE001.12

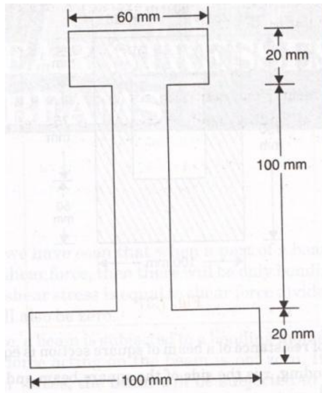
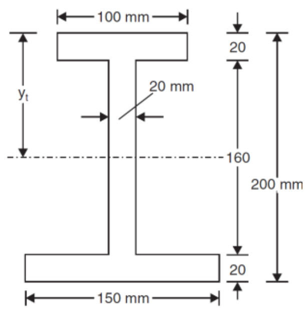
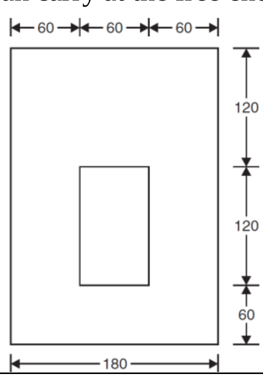
11	Of the following sections: rectangular, circular, triangular, I, T sections, which is most efficient for withstanding bending? Why?	Understand	CACE001.13
12	Under which conditions is the simple bending theory valid in practical applications?	Understand	CACE001.11
13	What do you mean by shear stress in beams?	Understand	CACE001.10
14	Write the expression for shear stress in a section of beam and explain the terms.	Understand	CACE001.10
15	Draw the bending stress and shear stress profiles for a rectangular beam section.	Understand	CACE001.12
16	Draw the bending stress and shear stress profiles for a circular beam section.	Understand	CACE001.11
17	Draw the bending stress and shear stress profiles for a hollow rectangular beam section.	Understand	CACE001.10
18	Draw the bending stress and shear stress profiles for a hollow circular beam section.	Understand	CACE001.10
19	Explain the concept of complimentary shear in longitudinal section of a beam which is transversely loaded.	Understand	CACE001.12
20	Of the following sections: rectangular, circular, triangular, I, T sections, which is most efficient for withstanding shearing stresses in beams? Why?	Understand	CACE001.12
Part – B (Long Answer Questions)			
1	Derive the bending equation for a beam.	Understand	CACE001.11
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?	Understand	CACE001.10
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?	Understand	CACE001.11
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.	Understand	CACE001.12
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.	Understand	CACE001.13
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.	Understand	CACE001.11
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?	Understand	CACE001.10
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.	Understand	CACE001.11

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.	Understand	CACE001.11
10	A beam is loaded by one couple at each of its ends, the magnitude of each couple being 5 kN-m. The beam is of steel and has a T-type cross section with the dimensions indicated in Figure. Determine the maximum tensile stress in the beam and its location, and the maximum compressive stress and its location. 	Understand	CACE001.10
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 $\tau = F\frac{A\bar{y}}{bI}$	Understand	CACE001.11
12	Consider a beam having an I-type cross section as shown in Fig. A shearing force *V* of 150 kN acts over the section. Determine the maximum and minimum values of the shearing stress in the vertical web of the section. 	Understand	CACE001.10
13	The beam shown in Fig. is simply supported at the ends and carries the two symmetrically placed loads of 60 kN each. If the working stress in either tension or compression is 125 MPa, what is the required moment ofinertia of area required for a 250-mm-deep beam? 	Understand	CACE001.11

14	Consider the simply supported beam subject to the two concentrated forces (60 kN each) shown in Fig. Now, the beam is of hollow circular cross section as shown in figure with an allowable working stress in eithertension or compression of 125 MPa. Determine the necessary outer diameter of the beam. 	Understand	CACE001.12
15	A beam 3 m long is simply supported at each end and carries a uniformly distributed load of 10 kN/m. The beam is of rectangular cross section, 75 mm X150 mm. Determine the magnitude and location of the peak bendingstress. Also, find the magnitude of the bending stress at a point 25 mm below the upper surface at the section midway between supports.	Understand	CACE001.13
16	A T-beam having the cross section shown in figure projects 2 m from a wall as a cantilever beam and carries a uniformly distributed load of 8 kN/m. Determine the maximum tensile and compressive bending stresses. 	Understand	CACE001.11
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.	Understand	CACE001.10
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.	Understand	CACE001.11
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.	Understand	CACE001.12
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.	Understand	CACE001.13
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?	Understand	CACE001.11

<table>
<tr><td>2</td><td>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.</td><td>Understand</td><td>CACE001.10</td></tr>
<tr><td>3</td><td>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?


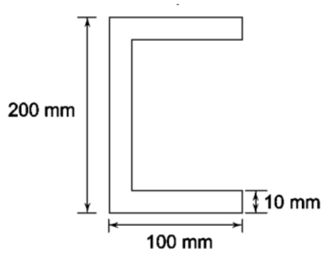
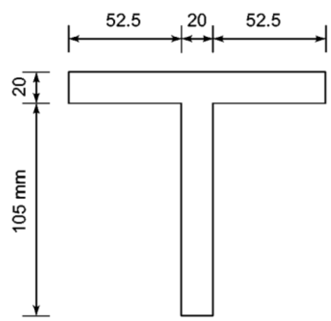

</td><td>Understand</td><td>CACE001.11</td></tr>
<tr><td>4</td><td>A simply supported beam is shown in figure. Find (a) the maximum normal stress in the beam, (b) the maximum shearing stress in the beam due to V, and (c) the shearing stress at a point 1 m to the right of R1 and 2cm below the top surface of the beam.

</td><td>Understand</td><td>CACE001.13</td></tr>
<tr><td>5</td><td>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.

</td><td>Understand</td><td>CACE001.11</td></tr>
</table>

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. 	Understand	CACE001.10
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.	Understand	CACE001.10
8	The unsymmetrical I-section shown in figure is the cross-section of a beam,which is subjected to a shear force of 60 kN. Draw the shear stress variation diagram across thedepth. 	Understand	CACE001.12
9	A cantilever beam of 1.2 m span is having cross-section as shown in figure. The permissiblestresses in tension and compressions are 20 N/mm^2 and 80 N/mm^2respectively. Determine the maximum concentrated load *W* it can carry at the free end. 	Understand	CACE001.12
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.	Understand	CACE001.11
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.	Understand	CACE001.10

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?	Understand	CACE001.11
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.	Understand	CACE001.12
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.	Understand	CACE001.11
15	A timber beam is to be designed to carry a load of 6 kN/m over a simply supported span of 5m.Permissible stress is 10 N/mm^2. Keeping the depth twice the width, design the beam. If the permissible stress in shear is 1 N/mm^2, check for shear.	Understand	CACE001.10
UNIT-IV			
TORSION OF CIRCULAR SHAFTS			
Part – A (Short Answer Questions)			
1	Define Torque, Polar section modulus and Proof resilience.	Remember	CACE001.14
2	Define Spring constant. Differentiate and explain types of springs.	Remember	CACE001.14
3	Derive the equation for power transmitted by a shaft.	Understand	CACE001.15
4	Define spring and mention types of springs.	Remember	CACE001.14
5	State functions of springs.	Understand	CACE001.14
6	Write torsional equation and explain the terms.	Remember	CACE001.14
7	Derive the expression for torque transmitted by a hollow shaft	Remember	CACE001.14
8	Write the Polar Modulus (i) for a solid shaft and (ii) for ahollow shaft.	Understand	CACE001.15
9	Why hollow circular shafts are preferred when compared tosolid circular shafts?	Understand	CACE001.14
10	Write the equation for strain energy stored in a shaft due totorsion.	Understand	CACE001.14
Part – B (Long Answer Questions)			
1	Differentiate and explain types of springs.	Understand	CACE001.15
2	a) Explain the theory of pure torsion with assumptions. b) Define solid length, spring rate, pitch	Remember	CACE001.15
3	State and explain the significance of the assumptions made in deriving the torsion equation. Also state the torsion equation, and explain what each term signifies. Provide a consistent set of units for each term.	Remember	CACE001.15
4	Derive the expression for torque transmitted by a hollow shaft	Understand	CACE001.16
5	a) Distinguish between close and open helical coil springs b) What is the value (i) maximum shear forces (ii) central deflection in a leaf spring subjected to an axial force? c) Write the equation for the deflection of an open coiled helical spring subjected to an axial load W.	Understand	CACE001.16
6	Derive the relation between Twisting moment, Shear stress and angle of twist.	Understand	CACE001.16

7	Derive expression equations for strength and stiffness of a circular shaft when an external torque T is acting on it.	Remember	CACE001.15
8	Derive expressions for polar modulus for a hollow circular shaft.	Remember	CACE001.15
9	Derive expression for strain energy for a solid circular shaft.	Remember	CACE001.15
10	Derive expression for strain energy for a hollow circular shaft.	Understand	CACE001.15
Part – C (Problem Solving and Critical Thinking)			
1	Calculate the maximum stress in a propeller shaft with a 400mm external and 200mm internal diameter, when subjected to a twisting moment of 4650Nm. If the modulus of rigidity, C=82GN/m^2, how much is the twist in a length 20 times the diameter?	Understand	CACE001.15
2	The stiffness of a closely coiled helical spring is 1.5 N/mm of compression under a maximum load of 100N. The maximum shearing stress produced in the wire of the spring is 130 N/mm2. The solid length of the spring (when the coils are touching) is given as 5cm. Find (i) Diameter of the wire (ii) Mean diameter of the coils and (iii) No. of coils required. Take C=4.5X10^4 N/mm^2.	Understand	CACE001.16
3	Determine the diameter of a solid steel shaft which will transmit 112.5kW at 200rpm. Also determine the length of the shaft if the twist must not exceed 1.50 over the entire length. The maximum shear stress is limited to 55 N/mm2. Take G = 8x10^4 N/mm^2.	Understand	CACE001.16
4	The internal diameter of a hollow shaft is 2/3rdof its external diameter.Compare its resistance to torsion with that of solid shaft of the same weight and material.	Understand	CACE001.14
5	A hollow shaft of diameter ratio 3/5 is required to transmit 800kW at 110rpm. The maximum torque being 20% greater than the mean. The shear stress is not to exceed 63MPa and the twist in a length of 3m is not to exceed 1.40. Calculate the minimum external diameter satisfying these conditions.	Understand	CACE001.15
6	A propeller shaft 280mm in diameter transmits 2.5mW at 250rpm. The propeller weighs 50kN and overhangs its support by 400mm. If the propeller thrust is of 123kN weights. Calculate the maximum principal stress induced in the cross-section and indicates its position. C=80MPa	Understand	CACE001.22
7	A hollow circular shaft, of outside diameter 50 mm and inside diameter36 mm, is made of steel, for which the permissible stress in shear is 90 MPa and G = 85 GPa. Find the maximum torque that such a shaft can carry and the angle of twist per metre length.	Understand	CACE001.15
8	A closely coiled helical spring of mean diameter 25 cm is made of 3 cm diameter rod and has 16 turns. A weight of 5kN is dropped on the spring. Find the height by which the weight should be dropped before striking the spring so that the spring may compressed by 20 cm. Take C=8X10^4 N/mm^2.	Understand	CACE001.16
9	A solid shaft has to carry a torque of 12 kNm. Find a suitable diameter for the shaftif the maximum stress is limited to 90 MPa and the angle of twist should not be more than 3^o per metre length. G = 85 GPa.	Understand	CACE001.17
10	In an open coil helical spring having 10 coils, the stresses due to bending and twisting are 98MPa and 105MPa respectively, and the spring is axially loaded. Assuming the mean diameter of the coils to be 8 times the diameter of wire, find the maximum permissible load and the diameter of wire for a maximum extension of 2cm. E=210GPa and G=82GPa.	Understand	CACE001.16

UNIT-V			
COLUMNS AND STRUTS			
Part - A (Short Answer Questions)			
1	Define column and effective length of a column. Distinguish between a column and a strut.	Remember	CACE001.18
2	Distinguish between short column and long column.	Remember	CACE001.18
3	Define slenderness ratio, crippling load.	Remember	CACE001.18
4	Explain the Limitations of Euler‘s Formula?	Remember	CACE001.18
5	What are the assumptions made in Euler‘s theory to arrive at buckling load on column.	Remember	CACE001.18
6	Calculate the slenderness ratio of a strut made from a hollow tube of 20mm outside diameter, 16mm inside diameter and 1.2m long.	Understand	CACE001.18
7	State the secant formula and explain each of the terms in it.	Understand	CACE001.18
8	Why is it necessary to use the minimum radius of gyration of a section to calculate the crippling load?	Remember	CACE001.18
9	What is the slenderness ratios of the column of square section of 30 mm side and length 2 m.	Understand	CACE001.20
10	Explain the parameters influencing buckling load of a long column.	Understand	CACE001.19
Part - B (Long Answer Questions)			
1	Derive the equivalent length of a column whose both ends are hinged using Euler's theory.	Remember	CACE001.19
2	Derive the equivalent length of a column for which one end is fixed and other end hinged using Euler's theory.	Remember	CACE001.19
3	Derive the equivalent length of a column for which both ends are fixed using Euler's theory.	Remember	CACE001.19
4	Derive the equivalent length of a column for which one end is fixedand other end is free using Euler's theory.	Remember	CACE001.20
5	Derive Rankine's formula.	Remember	CACE001.20
6	Explain the limitations of Euler's theory	Understand	CACE001.20
7	Derive the maximum and minimum stresses developed in eccentrically loaded long columns.	Understand	CACE001.18
8	Derive the equation for maximum deflection and stresses for a uniformly loaded lateral strut.	Understand	CACE001.19
9	Derive the maximum bending moment, maximum shear force for a circular beam loaded uniformly and supported on symmetrically placed columns.	Understand	CACE001.20
10	Derive the maximum bending moment for a semi-circular beam simply supported on three supports spaced equally.	Understand	CACE001.20
Part – C (Problem Solving and Critical Thinking)			
1	A hollow circular column of steel, of outer diameter 200 mm and thickness 5 mm, has a length of 4 m, with both ends fixed. Find the Euler critical load if E = 200 GPa. If the yield stress is 300 MPa, determine the length below which Euler's formula cannot be applied.	Understand	CACE001.20

2	The channel section shown in figure is used as a column, 3 m long, with both ends hinged. Compare the load carrying capacities obtained using Euler's and Rankine's formulae. E = 200 GPa and σy= 300 MPa.  	Understand	CACE001.18
3	A hollow steel strut, 2.4 m long, is pin-jointed at the ends. It has an outer diameter of 40 mmand a thickness of 5 mm. If the yield stress is 320 N/mm^2 and E = 200 GPa, comparethe crippling load given by Euler's and Rankine's formulae. Also determine the minimum *l/r* ratio for which Euler's formula applies.	Understand	CACE001.19
4	Determine the Euler critical load for the column section shown in figure if its length is 3 m and (i) if its ends are hinged and (ii) if its ends are fixed. *E* = 200 GPa.  	Understand	CACE001.20
5	What is the ratio of strength of a solid steel column of 150mm diameter tothat of a hollow circular steel column of the same cross-sectional area anda wall thickness of 15mm? The two columns have the same length andhave pinned ends.	Understand	CACE001.18
6	Determine the safe axial load a timber column of cross-sectional area150mm X 150mm and of 4m length can carry using a factor of safety, 8.Take E = 10kN/mm^2 and for (a)hinged ends (b) fixed ends (c)one end freeand other end fixed (d)one end hinged and other end fixed.	Understand	CACE001.19
7	From the Euler's crushing load for a hollow cylindrical cast iron column, 150mm external diameter and 20mm thick, if it is 6m long and hinged atboth ends. Compare this load with that obtained by the Rankinesformulausing constants 550N/mm^2 and 1/1600. For what length of the columnwould these two formulae give the same crushing loads? E for thematerial = 80kN/mm^2	Understand	CACE001.20

8	A steel column consists of two channels ISMC 300 X 35.8 kg/m placedback to back at a clear distance of 15cm and two plates of 350mm X20mm are connected to the flanges. Find the crippling load for thecolumn if the distance between the hinged ends is 8m. Take E =210kN/mm^2. Properties of channel sections: Area of cross-section of each channel = 45.64cm^2 Ixx = 6362.6 cm^4 Iyy = 310.8 cm^4 Cry = 2.36 cm Thickness of web = 7.6mm Thickness of flange = 13.6mm	Understand	CACE001.18
9	Compare the critical stresses using Euler's and Rankine's formulae for struts with slendernessratios 50, 100, 150, and 200. Assume that both ends are hinged. E = 200 GPa, Rankine's constant = 1/7500, and σy = 300 MPa.	Understand	CACE001.19
10	A cast iron column with a 10cm external diameter and 8cm internaldiameter is 3m long. Calculate the safe load using Rankine's formula if a)both ends hinged (b) both ends fixed (c) one end free and other end fixed(d) one end hinged and other end fixed. σc = 600N/mm2, α = 1/1600.Adopt factor of safety of 3.	Understand	CACE001.20

Prepared by: Dr. Venu M, Department of Civil Engineering.

HOD, CE