MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Department of Civil Engineering
Question Bank - Academic Year (2020-21)

Course Code & Course Name : 19CEC02 & Strength of Materials

Year/Sem/Sec : II/IV/-

Unit-I : ENERGY PRINCIPLES
Part-A (2 Marks)

1. Write down the expression for strain energy stored in a bar of cross-sectional area A and length 'l'and subjected to a tensile load W.
2. A beam of span 4m is cantilever and subjected to a concentrated load of 10 KN at free end. Find the total strain energy stored. Take the flexural rigidity is EI.
3. A mild steel bar of diameter 30mm and length 2.4 m is subjected to a tensile load of 90 KN. Find the strain energy stored in the bar if the load is applied gradually. What is the modulus of resilience if the proportional limit is 220 MPa. E=200 GN/m^2.
4. State the principle of virtual work.
5. Write the expression for strain energy stored in a body due to torsion.
6. State Castigliano's first theorem.
7. The external and internal diameters of a hollow shaft are 400 mm and 200 mm. Determine the maximum strain energy stored in the hollow shaft if allowable shear stress is 50 N/mm^2 and length 5 m. Take C=8*10^4 N/mm^2.
8. Write the expression for strain energy stored in a body due to shear.
9. The shear stress in a material at a point is given as 50 N/mm^2. Determine the strain energy per unit volume stored in the material due to shear stress. G=8*10^4 N/mm^2.
10. Write the expression for strain energy stored in a body due to bending (or) flexure.
11. Calculate the strain energy stored in the beam shown in the following figures. EI=constant.
12. Name any four methods used for computation of deflections in structures.
13. What are the assumptions made in unit load method?
14. Write the equation used for the determination of deflection at a given point in beams and frames.

15. What are the equilibrium equations?

16. What is the use of strain energy in structural analysis?

17. Differentiate between virtual force and virtual displacement.

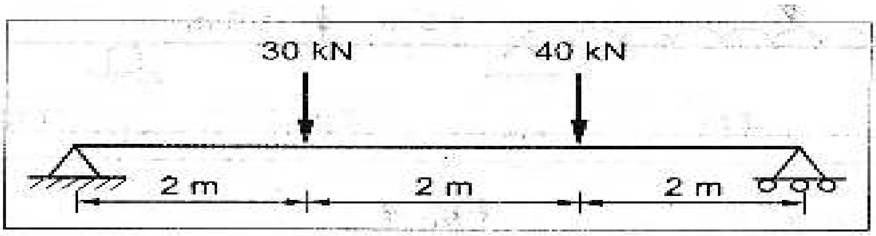
18. Write the equation for degree of indeterminacy of 2D trusses.

19. Calculate strain energy due to bending of a cantilever beam of span 6 m subjected to udl of 10 kN/m over entire length, EI is constant.

20. Differentiate determinate and indeterminate structure.

Part-B (16 Marks)

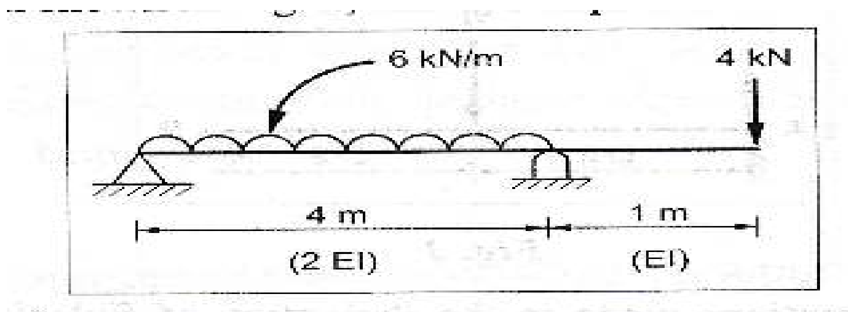
1. For the beam shown in Fig. find the deflection at C and slope at D (16)
$I=40x10^7mm^4$;E=200GPa.



2. A beam 4m in length is simply supported at the ends and carries a uniformly distributed load of 6 kN/m length. Determine the strain energy stored in the beam. Take E=200 GPa and =1440cm^4 (16)

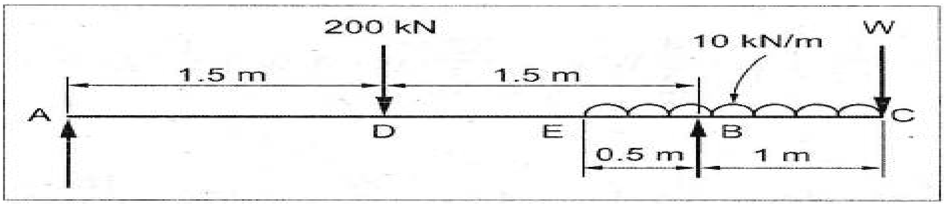
3. A beam simply supported over a span of 3 m carries a UDL of 20 KN/m over the entire span. The flexural rigidity EI=2.25 MN/m^2 .Using castigliano's theorem, determine the deflection at the centre of the beam. (16)

4. 1. For the beam shown in Fig. Find the slope and deflection at 'C' (16)



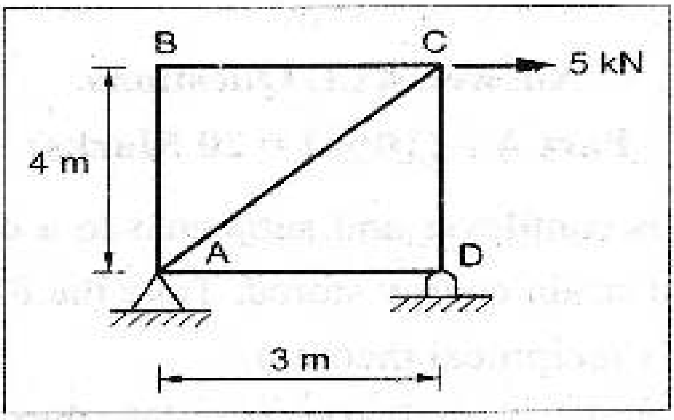
5. A simply supported beam of spam of span 3 m is carrying a point load of 20 KN at l m from the left support in addition to a u.d.l of 10 KN/m spread over the right half span. Using Castigliano's theorem, determine the deflection under the point load .Take El is constant throughout. (16)

6. Determine the deflection at the free end of the overhanging beam shown in figure. (16)



7. Using castingliano's theorem Calculate the cental deflection & the slope at ends of a SS beam carrying an UDL of intensity 'w' per unit length over the whole span (16)

8. For the truss shown in Fig. Find the horizontal movement of the roller at D. AB, BC,CD area 8 cm^2. (16)



9. For the truss shown in Fig. find the vertical deflection at 'C' cross sectional area of all the members: $100mm^2$. $E=2x10^5N/mm^2$ (16)

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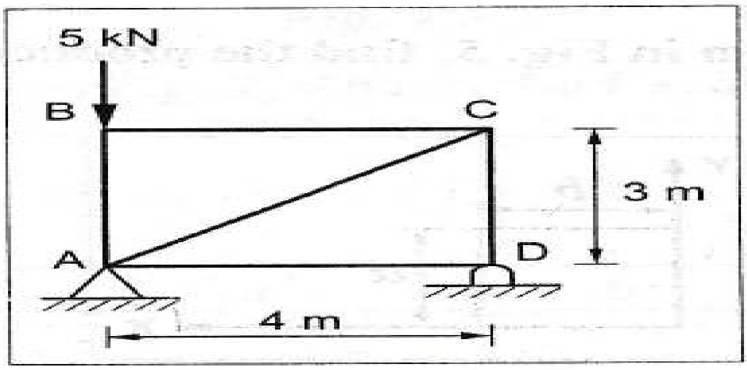
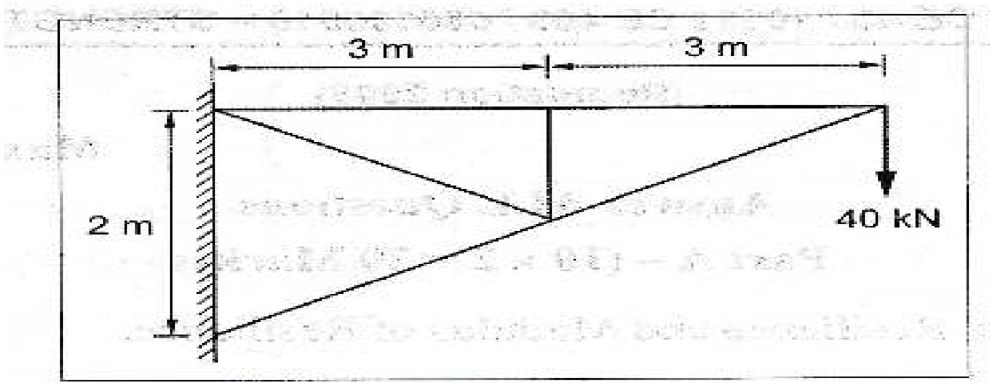


10. Determine the vertical deflection at the free end of the cantilever truss shown in Fig. Take cross sectional area of compression members as 850 mm^2 and tension member as 1000 mm^2.Modulus of elasticity=210 GPa for all the members. (16)



Unit-II : INDETERMINATE BEAMS

Part-A (2 Marks)

1. What are the merits and demerits of the fixed beam?
2. Draw BM diagram of a propped cantilever carrying a point load at the centre and propped at the free end.
3. A cantilever of length 6m carries a point load of 64 KN at its centre. The cantilever is propped rigidly at the free end. Determine the reaction at the rigid prop.
4. State the theorem of three moments.
5. Draw S.F and B.M diagram for a simply supported beam with a UDL and propped at the centre.
6. What is the value of prop reaction in a propped cantilever of span l, when it is subjected to (a) UDL over the entire span and propped at the free end, (b) UDL over the entire span and propped at the centre?
7. What are the merits and demerits of the fixed beam?
8. Draw the SF and BM diagrams of a fixed beam of L metre long carry a point load W at the centre.
9. Draw the SF and BM diagrams of a fixed beam of l metre long carries a point load W eccentrically placed on the beam.
10. What is the end moments and maximum deflection for a fixed beam AB of length l carrying a load W at a difference 'a' from end A.
11. What is the end moment for a fixed beam carrying a triangular load whose intensity varies from zero at one end to w per unit run at the other end.
12. Draw the S.F and B.M diagrams of a fixed beam of span 'L' m carries uniformly distributed load w/unit length throughout its length
13. A fixed beam of span 'L' is subjected to UDL throughout its length. What are the end

moments, bending moment at the centre and deflection?

14. Why the fixing moments, bending moment and deflection of the fixed beam carrying point load at the centre?

15. A fixed beam AB of 5 m span carries a point load of 20 KN at a distance of 2m from left support .Determine the deflection under the load and fixed moment, if EI-10810^3 kN-m^2.

16. A fixed beam AB of span 6 m carries a uniformly distributed load of 25kN/m over the entire span. Calculate the support moments.

17. A steel fixed beam AB of span 6 m is 60 mm wide and 100 mm deep. The support B sinks down by 6mm .Find the fixing moment at A and B. take E=200 GPa.

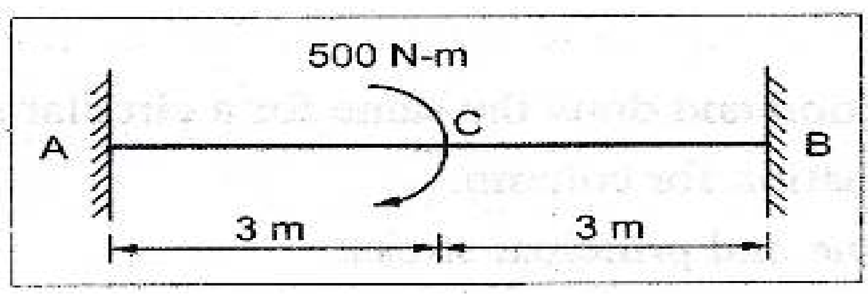
18. A fixed beam AB 8 m long is carrying a point load 100 kN at its centre. Take I-78810^8 mm^4,E=2.1810^5 N/mm^2 .Determine fixed end moments and deflection under load.

19. A fixed beam of 6m span carries a UDL of 2 kN/m run. If E=28x10^8kN/m^2 , I=0.48810^{-4} m^4 .Find (a) B.M at the centre,(b) maximum deflection.

20. Draw the deflected shape of a continuous beam.

Part-B (16 Marks)

1. 1. For the fixed beam shown in Fig. draw the SFD and BMD. (16)



2. A fixed beam AB of 4.5 m span carries a point load of 80 kN at its mid span and a uniformly distributed load of 15 kN/m throughout its entire span. Find the following. (16)

(i)Fixing moments at the ends and

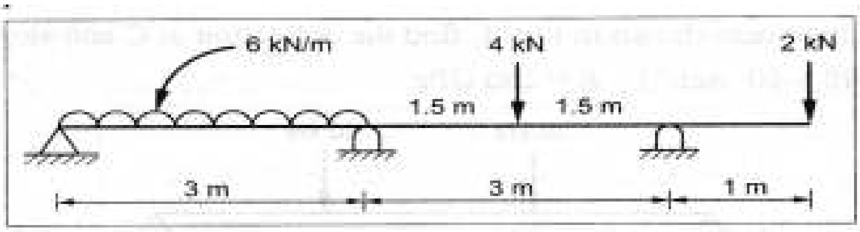
(ii) Reactions at the supports

3. A fixed beam of 6 m span is loaded with point loads of 150 KN at distance of 2 m from each support. Draw the bending moment diagram and shear force diagram. Also find the in maximum deflection. Take E=200 GPa and I=8x10^8 mm^4 (16)

4. A fixed beam AB is 6 m span and carries a point load 10KN at 1 m from left end. If also carries a clockwise moment at 1 m from right end, 10 KN-m. Draw SFD and BMD indicating the salient points. (16)

5. A propped cantilever of span 6 m is subjected to a u.d.lof 2 kN/m over a length of 4m from the fixed end. Determine the prop reaction and draw the shear force and bending moment diagrams**.** (16)

6. For the continuous beam shown in Fig. draw SFD and BMD all the supports are at same level. (16)



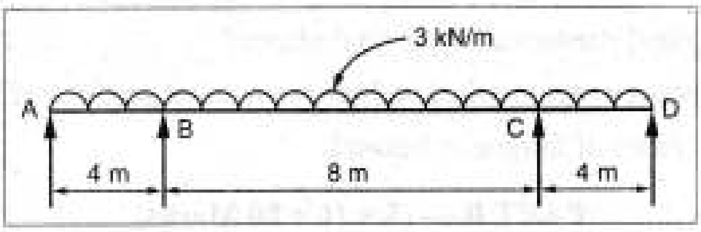
7. A continuous beam ABCD of uniform cross-section is loaded as shown in figure find the following: (16)

   (i) Bending moments at the supports

   (ii) Reactions at the supports.

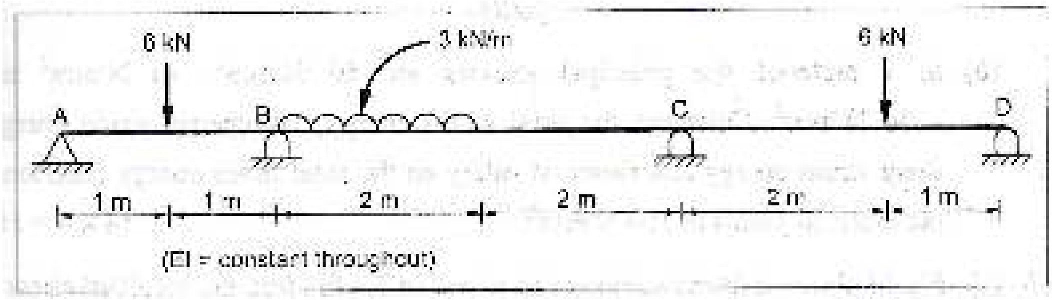
   (iii) Reactions at the supports.

   Also draw BM and SF diagrams.



8. A continuous beam consists of three successive spans of 6 m, 12 m and 4m and carries loads of 2KN/m. 1 KN/m and 3KN/m respectively on the spans. Draw bending moment diagram and shear force diagram for the continuous beam. (16)

9. A continuous beam ABCD is shown in Fig. 9 .Draw SFD and BWD indicating the salient points. (16)



10. A continuous beam ABCD 20m long is fixed at A, simply suppoted at D and carried on the supports B and C at 5 m and 12 m from the left end A. It carries two concentrated loads of 80 KN and 40 KN at 3 m and 8 m respectively from and uniformly distributed load of 12KN/m over the span CD. Analyse the beam by theorem of three moments and draw the shear force and bending moment diagrams. (16)

Unit-III : COLUMNS AND CYLINDERS

Part-A (2 Marks)

1. Differentiate column and strut.
2. What do you understand by the term 'slenderness ratio'?
3. Differentiate buckling load and safe load
4. Distinguish between thick and thin cylinder.
5. Differentiate short and long columns
6. How equivalent length of a column is described?
7. Write the effective length of column for the following end conditions.
8. Discuss Euler's formula for calculating the crippling load for a column (or) strut.
9. The actual length of a column is 10 m. Calculate its effective length when both ends of the column are (a) hinged, (b) fixed.
10. List out the assumptions made in the Euler's column theory.
11. What are the limitations of the Euler's formula?
12. Write Rankine's –Gordon formula.
13. Distinguish between eccentrically loaded column and axially loaded column.
14. Define core (or) kern of a column section.
15. Discuss about the middle third rule?
16. Write Johnson's parabolic formula.
17. State the expression for maximum stress developed in a column subjected to electric loading.

18. What you mean by contra flexure?

19. How many types of stresses are developed in thick cylinders?

20. What are the assumptions made in Lame's theory?

Part-B (16 Marks)

1. A hollow C.I column whose outside diameter is 200mm has a thickness of 20mm. It is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety 4. Calculate the slenderness ratio & the ratio of Euler's and Rankine's critical loads for cast iron f_e=550 N/mm^2 α=1/1600 & E=8x 10^4 N/mm^2 . (16)

2. A 1.5 m long cast iron column has a circular cross-section of 50 mm diameter.One end of the column is fixed in direction and position and the other is free. Taking factor of safety as 3, calculate the safe load using Rankine-Gordon formula.Take yield stress as 560 MPa and constant α=1/1600. (16)

3. Find the Euler crushing load for a hollow cylinder cast iron column 200mm external diameter 25mm thick,6m long and hinged at both ends. E=120 GN/m^2. Compare the load with the crushing load as given by the Rankine formula taking σ_c = 550 MN/m^2 and α=1/1600. For what length of column would these two formulas give the same crushing load? (16)

4. (i)What are the assumptions made in Euler's column theory? (16)

   (ii) Derive the Euler's crippling load for a column with one end fixed and the other end free.

5. (i) Find Euler's crippling load for a hollow cylindrical steel column of 38 mm external diameter and 2.5 mm thickness. The length of the column is 2.3 m and hinged at both ends. Take E=205 Gpa. Also determine the crippling load by Rankine's formula using constant as 335 kN/mm^2 and 1/7500. (16)

   (ii) Define 'thick cylinder' and draw the hoop stress distribution for a solid circular cylinder.

6. (i) Describe the Rankine's method for columns subjected to Eccentricity. (16)

   (ii) From the following data of a column of circular section calculate the extreme stresses on the column section. Also find the maximum eccentricity in order that there may be no tension anywhere on the section.

   External diameter =20cm

   Internal diameter =16

   Length of the column=4m

   Load carried by the column=175kN

   Eccentricity of the load = 2.5cm (from the axis of the column)

   End conditions = both ends fixed

Young's modulus = $94GN/m^2$

7. A Steel tube of 300 mm external diameter is to be shrunk on to another steel tube of 90 mm internal diameter. After shrinking, the diameter at the junction is 180 mm. Before shrinking on the difference of diameter at the junction is 0.12 mm. Find the (16)

   (i) The radial pressure at the junction

   (ii) The circumferential stresses developed in the two tubes after shrinking on. Take $E=200\ GN/mm^2$

8. a) Determine the maximum & minimum Hoop stress across the section of a pipe of 400 mm internal diameter & 100 mm thick. When the pipe contains a fluid at a pressure of $8\ N/mm^2$. Also sketch the radial pressure distribution 7 hoop stress distribution across the section. (16)

   b) A rectangular strut is 25 cm by 15 cm. It carries a load of 60 KN at an eccentricity of 2 cm in a plane bisecting the thickness. Find the minimum & maximum stresses developed in the section.

9. A compound tube is composed of a tube 100 mm internal diameter & 25 mm thick shrunk as a tube of 150 mm external diameter. The radial pressure at the junction is $8\ N/mm^2$. The compound tube is subjected to an internal fluid pressure of $84.5\ N/mm^2$. Find the variation of the hoop stress over the wall of the compound tube. (16)

10. A compound cylinder is to be made by shrinking on outer tube of 300 mm external diameter on to an inner tube of 150 mm internal diameter. Determine the common diameter at the junction if the greatest circumferential stress in the inner tube is to be two-thirds of the greatest circumferential stress in the outer tube. (16)

Unit-IV : STATE OF STRESS IN THREE DIMENSIONS

Part-A (2 Marks)

1. What are principal stresses and principal planes?
2. State the principal stress theory of failure.
3. State distortion energy theory for failure.
4. What are the various stress invariants for three dimensional state of stress?
5. Compute any two stress invariants of the stress tensor.
6. A bolt is subjected to an axial pull of 15 KN together with a transverse shear force of 5kN. Determine the diameter of bolt by maximum principal stress theory of permissible stress in tension is $100\ N/mm^2$.
7. State the Rankine's theory of elastic failure.

8. The principal stresses (MPa) at a certain point are 200 (tensile), 150(tensile) and 50(compressive) respectively. Determine the normal stress on the octahedral plane.

9. Write Gordon's formula..

10. What are the types of failure?

11. List the theories of failure.

12. Define maximum shear stress theory (or) coulomb's theory (or) Guest and Tresca theory.

13. Define maximum strain energy theory (or) Beltrami and Haigh's theory.

14. Write coulomb's formula

15. Write St.Venant's equation.

16. Write Beltrami and Haigh's equation

17. Write Von-mires formula.

18. Define volumetric strain.

19. Define dilatation.

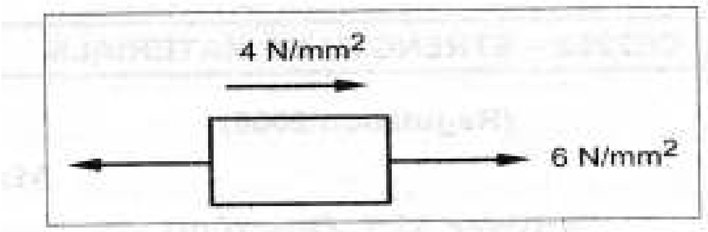
20. What is residual stress?

Part-B (16 Marks)

1. i) Briefly explain spherical and deviatory components of stress tensor. (16)

(ii) Explain the importance of theories of failure.

(iii) For the state of stress shown in Fig. find the principal plane and principal stress.



2. The rectangular stress components of a point in three dimensional stress system are defined as σ_x=20 MPa, σ_y=40 MPa, σ_z=80 MPa, τ_{xy} =40 MPA, τ_{yz}=-60 MPA, τ_{xz}=20 MPA. Determine the principal stresses at the given point (16)

3. The state of stress at a point is given by σ_x=80 Mpa, σ_y=20 Mpa, σ_z= -40 Mpa, τ_{xy}= -60 Mpa, τ_{yz}= τ_{zx}= 0 Mpa. Determine the three principal stresses and principal planes. (16)

4. At a point in a strained body subjected to 2 mutually perpendicular normal tensile stresses of magnitude of 30 Mpa & 12 Mpa accompanied to the shear stresses of 16 Mpa. Locate the principal planes and evaluate the principal stresses. Also calculate the maximum intensity of shear stress of and specify its planes. (16)

5. (i) The mild steel block has a cross section of 50 mm by 50 mm carries an axial load of 35 KN which is compressive in nature. Find the normal and tangential stresses across a plane through the point at 30° to the axis of the block. Also find the maximum shear in the block. (16)

(ii) A 5 mm thick aluminum plate has a width of 300 mm and a length of 600 mm subjected to full of 15000 N & 9000 N respectively in axial and transverse direction. Determine the normal, tangential and resultant stresses on a plane 40° to the greatest stress.

6. A circular shaft has to take a bending moment of 9000 N.m and torque 6750 N.m.The stress at elastic limit of the material is $207*10^6$Kpa & μ=0.25.Determine the diameter of the shaft, using octahedral shear stress theory and the maximum shear stress theory. Factor of safety=2. . (16)

7. (i)State maximum shear stress theory. (16)

(ii)A shaft is subjected to a maximum torque of 10 kNm and a maximum of bending moment of 8kNm at a particular section. If the allowable equivalent stress in simple tension is 160 MN/m^2 Find the diameter of the maximum shear stress theory

8. In a steel member, at a point the major principal stress is 200 MN/m^2 and the minor principal stress is compressive. If the tensile yield point of the steel is 235 MN/m^2 ,Find the value of the minor principal stress at which yielding will commence, according to each of the following criteria of failure (16)

(i)Maximum shearing stress.

(ii)Maximum total strain energy and

(iii)Maximum shear strain energy. Take Poisson Ratio=0.26

9. A Steel shaft is subjected to an end thrust producing a stress of50 MPa and the maximum shearing stress on the surface arising from torsion is 60 MPa. The yield point of the material in simple tension was found to be 300 MPa. Calculate the factor of safety of the shaft according to (16)

(i)Maximum shear stress theory

(ii) Maximum Distortion Energy Theory.

10. A cylindrical shaft made of steel of yield strength 350 MPa is subjected to static load consisting of bending moment of 10 KN-m and a torsional moment of 30 KN-m. Determine the diameter of the shaft using (16)

(i) Maximum principal stress theory

(ii) Maximum shear stress theory

(iii) Maximum strain energy theory and

(iv)Maximum distortion energy theory.

Take E=210GPa, Poisson's ratio=0.25 and factor of safety=2

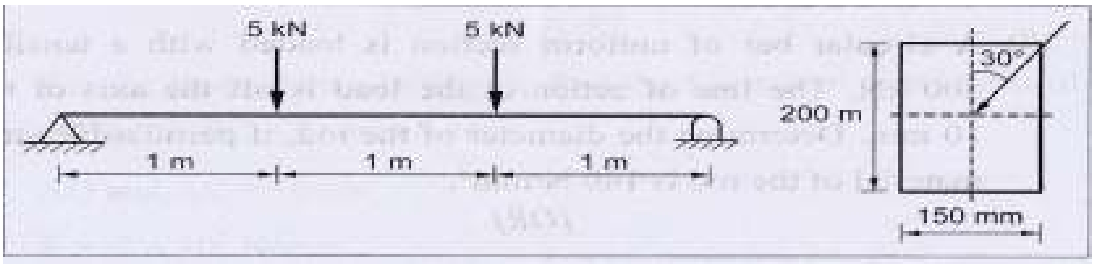
Unit-V : ADVANCED TOPICS IN BENDING OF BEAMS

Part-A (2 Marks)

1. What are the reasons for unsymmetrical bending?
2. Write the expression for position of neutral axis in case of curved bars.
3. Distinguish between symmetrical and unsymmetrical sections beams
4. What are the causes of fatigue in beams?
5. Write the Winkler-Bach formula for a curved beam.
6. Enumerate the assumptions made in Winkler-Bach theory for the determination of stresses in curved beams.
7. Define stress concentration
8. Write down the expressions for principal centroidal moments of inertia.
9. What do you mean by unsymmetrical bending?.
10. Define shear centre (or) Angle of twist..
11. What are the assumptions made in the analysis of curved bars?
12. Who postulated the theory of curved beam?
13. Define major and minor principal moment of inertia.
14. What is the shape of distributions of bending stress in curved beam?
15. What is the nature of stress in the inside section of a crane hook?
16. Where is the maximum stress in a ring under tension occurring?
17. What is the most suitable section for a crane?
18. Define pure bending of beam?
19. How will you calculate stress due to unsymmetrical bending?
20. What are the types of fractures?

Part-B (16 Marks)

1. 1. A rectangular simply supported beam is shown in Fig. The plane of loading makes 30^0 with the vertical plane of symmetry. Find the direction of neutral axis and the bending stress at A. (16)



2. Write brief technical note on: (16)

   (i) Unsymmetrical bending of beams

   (ii) Curved beams

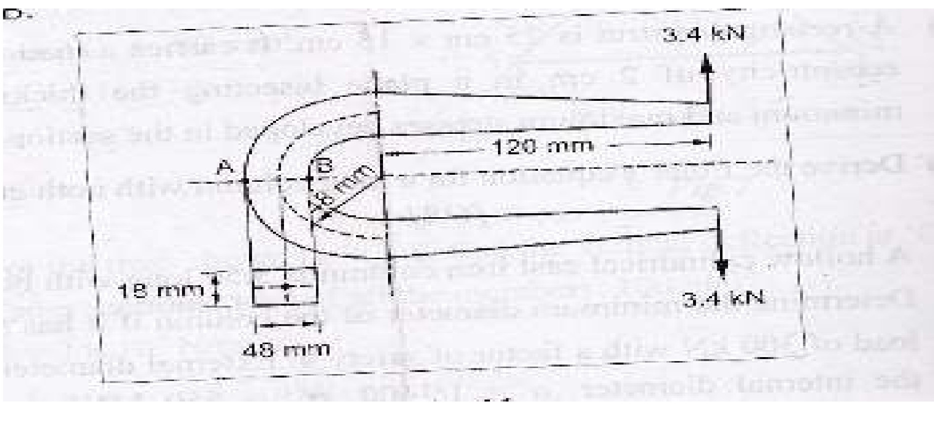
   (iii) Stress concentration

   (iv) Significance of shear centre.

3. A central horizontal section of hook is a symmetrical trapezium 60 mm deep, the inner width being 60 mm and the outer being 30 mm. Estimate the extreme intensities of stress when the hook carries a load of 30kN. The load line passing 40mm from the inside edge of the section and the centre of curvature being in the load line. (16)

4. A 80x80x10mm angle is used as a simply supported beam over a span of 2.4m. It carries a load of 400 kN along the vertical axis passing through the centroid of the section. Determine the resulting bending stress on the outer corners of the section along the middle section of the beam. (16)

5. Fig shows a frame subjected to a load of 3.4 kN find the resultant stress at A and B. (16)



6. A beam of T-section (flange 100x20mm, web 150mm x 10mm) in 3m in length and simply supported at ends (fig).It carries a load of 2.2kN inclined 20^{o} to the vertical and passing through the centroid of the section. Calculate the maximum tensile stress and maximum compressive stress. Also find the position of the neutral axis. (16)

7. A curved bar is formed of a tube of 120 mm outside diameter and 7.5mm thickness. The center line of this beam is a circular are of radius 225 mm. A bending moment of 3 kNm tending to increase curvature of the bar is applied. Calculate the maximum tensile and compressive stresses set up in the bar. (16)

8. A curved bar of rectangular section, initially unstressed is subjected to bending moment of 2000 Nm tends to straighten the bar. The section is 5cm wide and 6cm deep in the plane of bending and the mean radius of curvature is 10m. Find the position of neutral axis and the stress at the inner and outer face. (16)

9. A curved bar of rectangular section 60 mm wide by 75 mm deep in the plane of bending initially unstressed is subjected to bending moment of 2.25kNm which tends to straighten the bar. The mean radius of curvature is 150 mm. find (16)

    1. The position of the neutral axis

    2. The greatest bending stresses.

    Draw a diagram to show approximately how the stress varies across the section.

10. A beam of T-section having flange of 100x20mm and web of 150x10mm and 4m long is simply supported at its ends. it carries a 5KN at 40^{o} to vertical passing through the centroid of the section. Calculate the maximum tensile stresses and maximum compressive stresses. (16)

Course Faculty **HoD**