KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

NAMAKKAL- TRICHY MAIN ROAD, THOTTIAM

DEPARTMENT OF MECHANICAL ENGINEERING

CE8395/STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS

UNIT I

STRESS, STRAIN AND DEFORMATION OF SOLIDS

PART-A

1.What is Hooke's Law?
2.What are the Elastic Constants?
3.Define Poisson's Ratio.
4.Define: Resilience
5.Define proof resilience.
6.Define modulus of resilience.
7.Define principal planes and principal stresses.
8.Define stress and strain.
9.Define Shear stress and Shear strain.
10.Define volumetric strain.
11.Distinguish between Elasticity and Elastic Limit.
12.What does the radius of Mohr's circle refer to?
13.Derive a relation for change in length of a bar hanging freely under its our weights. What do you mean by Principal stress and Principal Plane?
14.Define Poison's Ratio.
15.Give the relationship between Bulk Modulus and Young's Modulus
16.Define: Shear modulus or Modulus of rigidity.
17.Give the relation between Modulus of Elasticity and Modulus of Rigidity
18.What is thermal Stress?
19.List the methods to find the stresses in oblique plane?

PART-B

1. A Mild steel rod of 20 mm diameter and 300 mm long is enclosed centrally inside a hollow copper tube of external diameter 30 mm and internal diameter 25 mm. The ends of the rod and tube are brazed together, and the composite bar is subjected to an axial pull of 40 kN. If E for steel and copper is 200 GN/m^2 and 100 GN/m^2 respectively, find the stresses developed in the rod and the tube also find the extension of the rod.

2. A bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on gauge length of 200 mm is 0.09 mm and the change in diameter is 0.0039 mm. calculate the Poisson's ratio and the values of the three moduli.

3. A bar 30mm in diameter is subjected to a tensile load of 54kN and the measured extension on 300mm gauge length is 0.112mm and change in diameter is 0.00366mm. Calculate poison's ratio and the values of three moduli.

4. A tapered circular bar tapers uniformly from a diameter d at its small end to D at its big end. The length of the bar is L. Derive an expression for the elongation of the bar due to an axial tensile force P.

5. The bar shown in fig.1 is subjected to a tensile load of 160kN.If the stress in middle portion is limited to 150 N/mm^2; determine the diameter of the middle portion. Find also the length of the middle portion if the total elongation of the bar is to be 0.2mm. Young's modulus is 2.1×10^5N/mm^2.

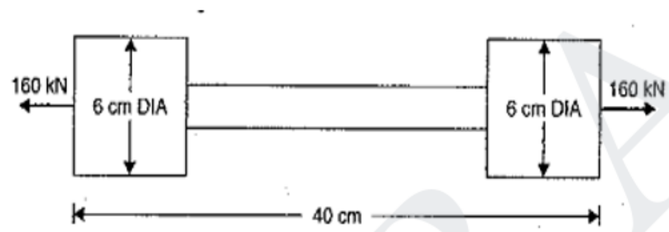


Figure-1

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 same length. The compound tube carries an axial compression load of 900kN.Find the stresses and load carried by each tube and the amount of its shortens. Length of each tube is 140mm.Take E for steel as 2×10^5N/mm^2 and for brass 1×10^5N/mm^2.

7. Two members are connected to carry a tensile force of 80kN by a lap joint with two number of 20mm diameter bolt. Find the shear stress induced in the bolt.

8. A reinforced concrete column 500mm×500mm in section is reinforced with 4 steel bars of 25mm diameter; one in each corner, the column is carrying a load of 1000kN.Find the stresses in the concrete and steel bars. Take E for steel=210×10^3 N/mm^2 and E for concrete=14×10^3 N/mm^2

9. A point in a strained materials is subjected to the stress as shown in fig.2.Locate the principal plane and find principal stresses.

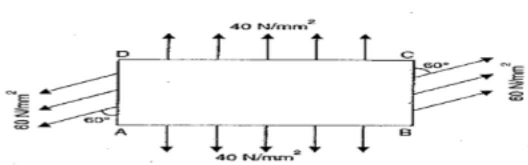


Figure-2

10. A point in a strained materials is subjected to stresses as shown in fig.3.Using Mohr's Circle method, determine the normal and tangential stress across the oblique plane. Check the answer analytically.

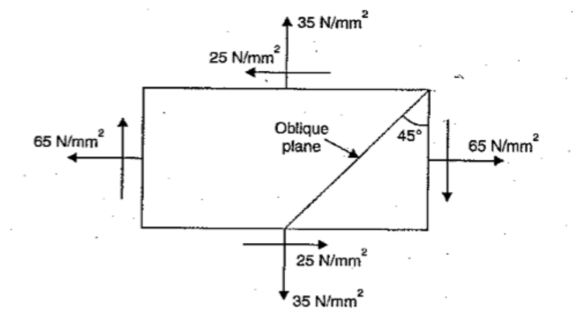


Figure-3

11. At a point in a strained material the principal stresses are 100 N/mm^2 (tensile) and 60 N/mm^2 (compressive). Determine normal stress, shear stress, resultant stress on a plane inclined at 50 degrees to the axis of the major principal stress. Also determine the maximum shear stress at the point.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM

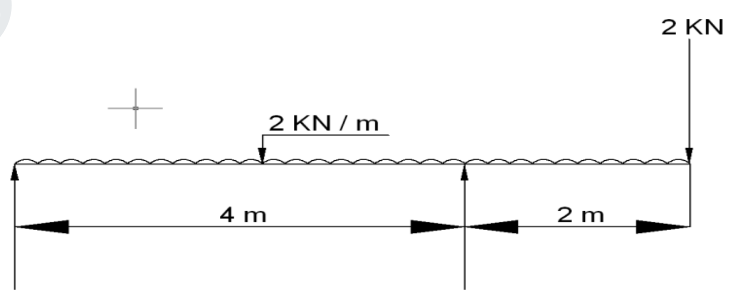
PART-A

1.State the different types of supports.
2.What is cantilever beam?
3.Write the equation for the simple bending theory.
4.What do you mean by the point of contraflexure?
5.What is mean by positive or sagging BM?
6.Define shear force and bending moment.
7.What is Shear stress diagram?
8.What is bending moment diagram?
9.What are the different types of loading?
10.Write the assumption in the theory of simple bending.
11.What are the types of beams?
12.When will bending moment is maximum.
13.Draw the S.F and B.M diagrams for cantilever of length L carrying a point load W at the free end.
14.What are flitched beams?
15.What is meant by shear stresses in beam?
16.What is the value of bending moment corresponding to a point having a zero shear force?
17.Define bending moment in beam.
18.What is meant by Neutral axis of the beam?
19.What are the benefits of method of sections compared with other methods?
20.What are maximum shear stresses at any point in a cylinder?

PART-B

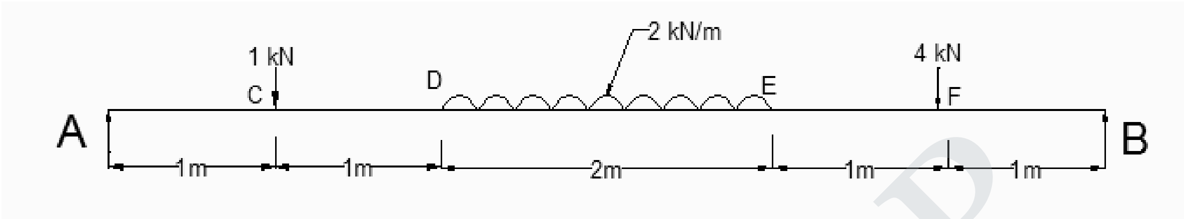
1.A beam of triangular cross section having base width of 100 mm and depth of beam height of 150 mm is subjected to a shear force of 15 kN. Find the value of maximum shear stress, and sketch the shear stress distribution a long the beam.

2.Draw the shear force and bending moment diagrams for the beam shown in below fig. Also determine the maximum bending moment and locate the point of contraflexure.



3.State the assumptions made in the theory of simple bending and derive the simple bending equation. (May/June2013)

4.Draw the shear force and bending moment diagram for the simply supported beam as shown below. Clearly mark the position of the maximum bending moment and determine its value. (Nov/Dec2013)



5.A beam ABC 8 m long has the support at the end A and other support at B 6 m from A. It carries a uniformly distributed load of 6 kN/m over the entire length and a point load of 10 kN at the end C. Draw the shear force and bending moment diagrams.(Nov/Dec2014)

6.A Simply supported beam of 16m effective span carries the concentrated loads of 4kN,5kN,and 3kN at distances 3m,7m and 11m respectively from the left support. **Calculate** maximum shearing force and bending moment. Draw S.F and B.M diagrams.(May-18)

7.A cantilever of length 2m carries a uniformly distributed load of 2kN/m length over the whole length and a point load of 3kN at the free end. Draw the S.F and B.M diagrams for the cantilever.(Dec-2017)

8.A horizontal beam AD 15m long carries a UDL of 6kN/m run together with a concentrated load of 9kN at the left end A. The beam is supported at a point B which is 3m from A and C which is in the right hand half of the beam and x m from D. **Determine** the value of x, if the midpoint of the beam is the point of contraflexure. Plot the SF and BM diagrams.

9.A timber beam of rectangular section is support a load of 50kN uniformly distributed over a span of 4.8m when beam is simply supported. If the depth of section is to be twice the breadth, and the stress in the timber is not to exceed 7N/mm2,Find the dimensions of the cross section.

10.a).A I section beam 350x 200mm has a web thickness 0f 12.5mm and a flange thickness of 25mm.It carries a shearing force of 20 tonnes at a section.Sketch the shear stress distribution across the section.

UNIT III **TORSION**

PART-A

1.Define torsional rigidity of the solid circular shaft.
2.Distinguish between closed coil helical spring and open coil helical spring.
3.What is meant by composite shaft?
4.What is called Twisting moment?
5.What is Polar Modulus?(May/June2010)
6.Define torsional rigidity of a shaft.
7.What do mean by strength of a shaft?
8.Write down the equation for Wahl factor.
9.Define torsional stiffness.
10.What are springs? Name the two important types.
11.What is meant by Spring Constant?(April/May-2017)
12.The shearing stress in a solid shaft is not to exceed 40N/mm2 when the torque transmitted is 20000N-m.Determine the minimum diameter of the shaft.(Nov/Dec-15)
13.Write down the equation for the maximum deflection of a cantilever beam carrying a central point load ‘W’.(April/May-17)
14.What is meant by torsional rigidity?(Nov/Dec-14)
15.Compute the torsional rigidity of a 100mm diameter,4m length shaft take C=80kN/mm^2
16.What are the assumptions made in torsion equation? (May/June 2009)
17.What is the ratio of maximum shear stress to the average shear stress in the case of solid circular section?
18.Find the torque which a shaft of 50mm diameter can transmit safely, if the allowable shear stress in 75 N/mm^2?
19.What is the shear stress distribution value of Flange portion of the I-section?
20.Write down the expression for power transmitted by a shaft.(May-June/2013)

PART-B

1. A hollow shaft with diameter ratio 3/5 is required to transmit 450 kW at 120 rpm. The shearing stress in the shaft must not exceed 60 $N/mm^2$and the twist in a length of 2.5 m is not to exceed 1°. Calculate the minimum external diameter of the shaft. C = 80 kN/mm^2**(May/June2013)**

2. A steel shaft is required to transmit 75 kW power at 100 r.p.m. and the maximum twisting moment is 30% greater than the mean. Find the diameter of the steel shaft if the maximum stress is 70 N/mm2. Also determine the angle of twist in a length of 3 m of the shaft. Assume the modulus of rigidity for steel as90 kN/mm^2. **(April/May 2011)**

3. The stiffness of a close coiled helical spring is 15 N/mm of compression under a maximum load of 60 N. The maximum shearing stress produced in the wire of spring is 125 N/mm^2. The solid length (when the coils are touching) of the spring is given as 5cm. Find,**(May/June 2012)**

i. Diameter of wire
ii. Mean diameter of the coil sand
iii. Number of coils required. Take modulus of rigidity = 4.5 x $10^4 N/mm^2$.

4. A closely coiled helical spring has stiffness of 10 N/mm. Its length when fully compressed with adjacent coils touching each other is 400 mm. The modulus of rigidity of the material of the spring =80 GPa. **(May/June2013)**

i. Determine the wire diameter and mean coil diameter if their ratio is1/10.
ii. If the gap between any two adjacent coil is 2 mm, what maximum load can be applied before the spring becomes solid (adjacent coils touch).
iii. What is the corresponding maximum shear stress in the spring?

5.Calculate the maximum intensity of shear stress induced and the angle of twist produced in degrees in solid shaft of 100 mm diameter, 12 m long, transmitting 150 kW at 200 rpm. Take G=82kN/mm^2.

6.**Determine** the bending stress, shear stress and total work done on an open coiled helical spring subjected to axial force having mean radius of each coil as 'r' and 'n' numbers of turns.(May/June-2014)

7.The internal and external diameter of a hollow shaft is in the ratio of 2:3.The hollow shaft is to transmit a 400 kW power at 120rpm.The maximum expected torque is 15% greater than the mean valve. If the shear stress is not to exceed 50Mpa,**find** section of the shaft which would satisfy the shear stress and twist conditions. Take

$G=0.85\times10^5$MPa.(May/June-2013,15)

8.A hollow shaft, having an inside diameter is 60% of it is outer diameter is to replace the solid shaft is transmitting in the same power and same speed. **Calculate** percentage in saving materials, if the materials is to be also the same.(Aril/May-17)

9.A solid shaft has to transmit the power 105 kW at 2000rpm.The maximum torque transmitted in each revaluation exceeds the mean by 36%.Find the suitable diameter, if the shear stress is not to exceed 75N/mm2 and maximum angle of twist is 1.5◦ in a length of 3.30m and G=0.80×105 N/mm2 (Nov/Dec-2016)

10.A laminated spring carries a central load of 5200N and it is made of 'n' number of plates,80mm wide,7mm thick and length 500mm.Find the number of plates, if the maximum deflection is 10mm.Let E=2×105 N/mm2 (Nov/Dec-2016)

11.A stepped solid circular shafts is built in at its ends and subject to an external applied torque T at the shoulder as shown in Fig.3.Determine the angle of rotation θ of the shoulder section when T is applied.(Nov/Dec-2016) (7)

12. A closed coiled helical spring is to be made out of 5mm diameter wire 2m long so that it deflects by 20mm under an axial load of 50N.Determine the mean diameter of the coil. C=8.1×104 N/mm2.

13.**Derive** a relation for deflection of a closely coiled helical spring subjected to an axial downward load W.(May/June-2013)

UNIT IV DEFLECTION OF BEAMS

PART-A

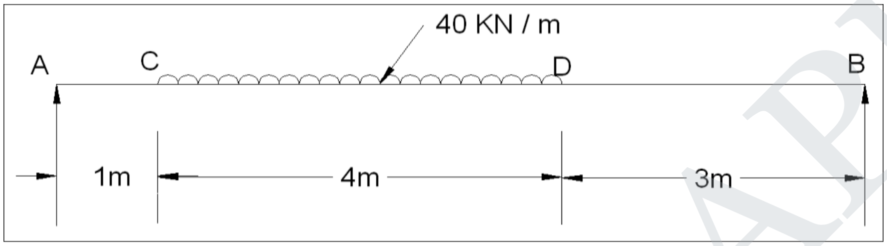
1.Mention any two methods of finding the slope and deflection of beams.
2.State Maxwell's Reciprocal Theorem.
3.Define Flexural Rigidity of beams.
4.What is the significance of finding beam deflection?
5.State the condition for the use of Macaulay's method.
6.What is the relation between slope, deflection and radius of curvature of a beam?(Nov/Dec 2012)
7.State two assumptions made in the Euler's column's theory(May/June2012)
8.Write the equivalent length of column for a column.(Nov/Dec 2012)
9.Describe the double integration method.(May/Jun 2010)
10.Calculate the effective length of a long column, whose actual length is 4m when i)both ends are fixed ii)one end is fixed while the other end is free?(Nov/Dec2011)
11.Define crippling load.(May/Jun 2011)
12.In a simply supported beam how will you locate point of maximum bending moment?
13.Define: Moment of resistance
14.Define column(May/Jun 2010)
15.Define shear force and bending moment?
16.Define: Neutral Axis
17.What is maximum bending moment in a simply supported beam of span 'L' subjected to UDL of 'w' over entire span?
18.State the limitations of Euler's formula.
19.What is the relation between slope, deflection and radius of curvature of a beam?
20.When will bending moment is maximum?

PART-B

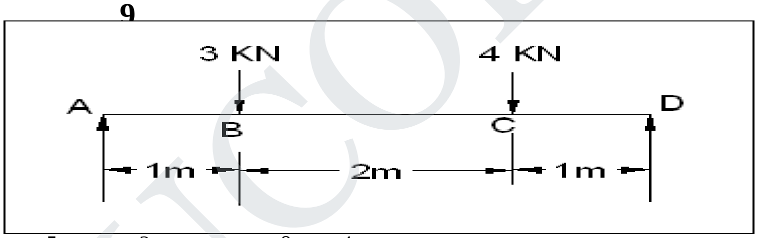
1.A beam of length 6 m is simply supported at the ends and carries two point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Compute,
i. Slope and deflection under each load.(ii)Maximum deflection(iii).The point at which maximum deflection occurs. Assume E = 2 x 10^5 N/mm^2 and I = 85 x10^6 mm^4. **(May/June2012)**

2.A simply supported beam of span L is subjected to two equal loads w/2 at each of 1/3rd span points. Find the expressions for deflection under the loads and at the mid span. Use Moment Area Method. **(Nov/Dec2014)**

3.Determine the deflection of the beam at its midspan and also the position of maximum deflection and maximum deflection. Take E = 2 x 10^5N/$mm^2$and I = 4.3 x $10^8$$mm^4$.Use Macaulay's method. The beam is shown in fig below: **(Nov/Dec2014)**



4.Using conjugate beam method determine the,
(i)Slope at each end and under each load
(ii) Deflection under each load for the beam as shown in below fig. **(Nov/Dec2014)**



Take E = 2 x 10^5N/$mm^2$and I = $10^8$$mm^4$

5.Determine the deflection of a given beam at the point loads. Take I = 64x10-4 mm4 & its Young's modulus (E) = 210x106 N/mm2. (April/May 2011)

6.A steel cantilever beam of 6m long carries 2 point loads 15KN at the free end and 25KN at the distance of 2.5m from the free end. To determine the slope at free end & also deflection at free end I= 1.3x108mm4. E = 2x105 N/mm2 (Apr/May 2008)

7.Derive the formula to find the deflection of simply supported beam with point load W at the centre by moment area method.

8.Derive the Maxwell Reciprocal theorem.

9.A simply supported beam of span l is carrying a point load W at the centre and UDL of intensity of w per length. Show that Maxwell's reciprocal theorem holds goods at the centre of the beam.

10.A simply supported beam of span 5.80 m carries a point load of 37.50kN.Find the maximum slope and deflection let EI=40000kN/m2.Use Conjugate beam method.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS

PART-A

1. Define hoop stress/circumferential stress.
2. Define longitudinal stress?
3. What do you mean by a thick compound cylinder? How will you determine the hoop stresses in a thick compound cylinder?
4. Find the thickness of the pipe due to an internal pressure of 10 N/mm2 if the permissible stress is 120 N/mm^2. The diameter of pipe is 750mm.
5. A cylindrical pipe of diameter 1.5 m and thickness 1.5 cm is subjected to an internal fluid pressure of 1.2 N/mm^2. Determine the longitudinal stress developed in the pipe.
6. Write down the Lame's equations.(May-2018)
7. Define thin cylinders.(Dec-2017)
8. List the assumption made in Lame's equations.(Dec-2015)
9. Define radial pressure in thin cylinder. (Dec-2016)
10. What are assumptions involved in the analysis of thin cylindrical shells? (April/May 2011)
11. List out the modes of failure in thin cylindrical shell due to an internal pressure
12. Write the circumferential strain in thin spherical shell.
13. What is the effect of riveting a thin cylindrical shell?
14. Difference between cylindrical shell and spherical shell.
15. State the expression for maximum shear stress in cylindrical shell.

PART-B

1.A cylindrical shell 3 m long which is closed at the ends has an internal diameter of 1m and a wall thickness of 15 mm. young's modulus 200 GN/m^2 and Poisson's ratio=0.3 calculate the circumferential and longitudinal stresses induced and also change in diameter and change in length of the shell. If it is subjected to an internal pressure of 1.5 MN/m^2.**(Nov/Dec2012)**

2.Derive the expression for the change in diameter and for the change in volume of a thin spherical shell when it is subjected to an internal pressure. **(Nov/Dec2012)**

3.A cylindrical thin drum 80 cm in diameter and 3 m long has a shell thickness of 1 cm. If the drum is subjected to an internal pressure of 2.5 N/mm^2. Take E = 2 x 10^5 N/mm^2 and Poisson's ratio=0.25.Determine, **(May/June2012)**

i. Change in diameter
ii. Change in length
iii. Change in volume.

4.A thin cylinder is 3.5 m long, 90 cm in diameter and the thickness of metal is 12 mm. It is subjected to an internal pressure of 2.8 N/mm^2. Calculate the change in dimensions of cylinder and the maximum intensity of stress induced. Given E = 200 GPa and

Poisson's ratio=0.3. **(May/June2013)**

5.A boiler shell is to be made of 15 mm thick plate having tensile stress of 120 MPa. If the efficiencies of the longitudinal and circumferential joints are 70% and 30 % respectively, determine: **(Nov/Dec2013)**

(a). Maximum permissible diameter of the shell for an internal pressure of 2 MPa (b). Permissible intensity of internal pressure when the shell diameter is 1.5 m.

6.Find the thickness of metal necessary for a thick cylindrical shell of internal diameter 160 mm to withstand an internal pressure of 8 N/mm^2. The maximum hoop stress in the section is not to exceed35N/mm^2. **(Nov/Dec2014)**

7.A thick pipe of 300 mm external diameter and 200 mm internal diameter is subjected to an internal pressure of 12 MPa. What minimum external pressure can be applied so that the tensile stress in the metal shall not exceed 16 MPa.**(Nov/Dec2014)**

8.A water main 80cm diameter contains water at a pressure head of 100m.If the weight density of water is 9810N//m^3,**find** the thickness of the metal required for the water main. Given the permissible stress as 20N/mm^2(Dec-2017)

9.A pipe of 600mn internal diameter and 800mm external diameter contains a fluid pressure of 8 N/mm2.**Find** the minimum and maximum hoop stress across the section. Also sketch the radial pressure distribution and hoop stress distribution across the section.

10.Find the thickness of metal necessary for a cylindrical shell of internal diameter 150mm to withstand an internal pressure of 25N/mm$^{2.}$The maximum hoop stress in the section is not to exceed 125N/mm$^{2.}$