2) A reinforced concrete column 300mmX 300mm is reinforced with 8 steel rods with a total area of $1820mm^2$. The column carries an axial load of 400kN. If the modulus of elasticity of steel is 18 times that of concrete: find the stresses in concrete and steel. Take $E = 2 \times 10^5$ N/mm^2.

3) An aluminium tube of 40mm external diameter and 20mm internal diameter is fitted on a solid steel rod of 20mm diameter. The composite bar is loaded in compression by an axial load P. Find the stress in steel when the load is such that the stress in aluminium is 70 kN/mm^2. What is the value of P? Take $E_s = 210$ kN/mm^2 : $E_{al} = 70$ kN/mm^2.

4) A steel bar 250mm long and 50mm x 50mm in cross section is subjected to a tensile load of 400kN along longitudinal axis and compressive load of 600kN on each side. Under the action of above loads, the change in volume is observed to be $0.08cm^3$. Determine the values of Poisson's ratio, bulk modulus and modulus of rigidity. Take $E = 2 \times 10^5$ N/mm^2.

5) A mild steel bar 6m long is 5cm in diameter for 3m of its length and 2.5cm dia for the remainder of its length. The bar is in tension and the stress on the smallest section is 1.12×10^8 N/m^2. Find the total elongation of the bar and the change in diameter at the smallest section. $E = 2.07 \times 10^{11}$ N/m^2. Poisson's ratio =0.25

6) A bar of steel is 0.7m long. For the first 0.2m it is 25mm diameter for the next 0.3m it is 20mm in diameter and for the remaining 0.2m it is 15mm in diameter. Find the change in length if it is subjected to a tensile load of 100kN. Take $E = 0.21$ MN/mm^2

7) A reinforced concrete column is 350mm x 350mm in cross section. The reinforcement consists of 4 bars of 25 mm dia round steel rods, one rod being placed close to each corner of cross section. If a compressive load of 600 kN is supported by this column, what is the load and stress in concrete and in the reinforcing bars. Take $E_s = 2 \times 10^5$ N/mm^2 and $E_c = 0.2 \times 10^5$ N/mm^2

8) A mild steel bar 10m long is 5cm in diameter for 5m of its length and 3cm dia for the remainder of its length. The bar is in tension and the stress on the smallest section is 1.12×10^8 N/m^2. Find the total elongation of the bar and the change in diameter at the smallest section. $E = 2.07 \times 10^{11}$ N/m^2.

9) An axial pull of 40 kN is acting on a bar consisting of three sections of length 300mm, 250mm and 200mm and of diameters 20mm, 40mm and 50mm respectively. If the Young's modulus $= 2 \times 10^5 N/mm^2$, determine (i) stress in each section and (ii) total extension of the bar.

10) A steel bar 300mm long and 100mm x 100mm in cross section is subjected to a tensile load of 500kN along longitudinal axis and compressive load of 700kN on

shaft is 80Gpa.If the maximum shear stress should not exceed 100Mpa. calculate maximum safe load that can be applied to the spring under this load. Calculate the strain energy stored by the spring.

7) A hollow shaft of diameter ratio 3/5 is required to transmit 80kW at 110 rpm. the maximum torque being 12% greater than the mean. The shear stress is not to exceed 60 MPa and the twist in a length of 3m is not to exceed 1°. Calculate the minimum external diameter satisfying these conditions.

8) A leaf spring carries a central load of 2.5kN. The leaf spring is to be made of 10 steel plates 6cm wide and 5mm thick.If the bending stress is limited to 100N/mm^2. determine (i) length of the spring and (ii) deflection at the centre of the spring. Take E= 2×10^5 N/mm^2.

UNIT-V

1. A steel bar 15mm in diameter is pulled axially by a force of 12 KN. If the bar is 320mm long calculate the strain energy stored by the bar. Take E=2×10^5 N/mm^2.

2. Two elastic bars of same material and length one of circular section of diameter 150mm and other of square section of side 100mm absorb the same amount of Strain energy delivered by the axial forces. Compare the stresses in the two bars.

3. An uniform metal bar has a cross sectional area of 700mm^2 and a length of 1.5m with one elastic limit of 160n/mm^2. What is its proof resilience? Find also the maximum value of an applied load which may be suddenly applied load which may be suddenly applied without exceeding the elastic limit. Calculate the value of the gradually applied load. which will produce the same extension as that produced by the above suddenly applied load. Take E = 2×10^5 N/mm^2.

4. An unknown weight falls through 10mm on a collar of rigidity attached to the lower end of a vertical bar 3m long and 600mm^2 in section. If the maximum instantaneous extension is known to be 2mm. What is the corresponding stress and the value of the weight?

5. A bar 3m long and80mm in diameter. It is subjected to a tensile load of 150 KN. Find the stress and the elongation when the load is applied gradually. What would be the maximum stress and the maximum elongation if the load has been suddenly applied? Take E= 2×10^5 N/mm^2.

6. A 18mm dia mild steel bar 1.25m is stressed by a weight of 150N dropping freely through 14mm. before starting to stretch. Find the maximum instantaneous stress and the elongation produced in the bar if E= 2×10^5 N/mm^2.

each side. Under the action of above loads, the change in volume is observed to be 0.09cm^3. Determine the values of Poisson's ratio, bulk modulus and modulus of rigidity. Take E= 200 Gpa.

UNIT-II

1) A simply supported beam of span 6m is loaded with a udl of 3 kN/m over a length of 2m starting from a distance of 1m from left end. Draw S.F and B.M diagrams for the beam and find the magnitude and position of maximum B.M.

2) A cantilever beam 5m long carries point loads of 3kN, 4kN and 6kN at distances of 1.5m, 3m and 4.5m from the fixed end. In addition to this the beam carries a udl of 2kN/m over the entire length of the beam. Draw S.F and B.M. diagrams.

3) A beam 9m long is simply supported at its ends. It carries a uniformly distributed load of 25kN/m run over the length of left half of its span, together with concentrated loads of 20kN and 30kN situated at 1.5m and 4.5m respectively form the right hand support.Draw the S.F and B.M diagrams for the beam and find out the magnitude and position of the maximum B.M.

4) A simply supported beam is of 10 m span. The cross section of the beam is 200 mm wide and 400 mm deep. Find the safe uniformly distributed load the beam can carry so that the bending stress and shear stress are limited to 150 N/mm^2 and 80 N/mm^2 respectively.

5) A symmetrical I section has the flange 1000 mm x 100 mm and its web 100 mm x 700mm. The section is subjected to a bending moment of 125 kNm. Draw the bending stress distribution across the cross section.

6) A simply supported beam AB of 5m span carries a udl of intensity 20kN/m between 1m and 3.5m from the left end and a concentrated load of 60 kN at 1m from the right end. Draw the shear force and bending moment diagram for the beam. Also find the magnitude and position of the maximum bending moment

7) A simply supported beam is carrying a udl of 2kN/m over a length of 3m from the right end.The length of the beam is 6m. Draw the S.F and B.M diagrams for the beam and also calculate the maximum B.M on the section.

UNIT-III

1) A simply supported beam of rectangular cross-section 50 x 25 mm and 3 m long is carrying a u.d.l. of 1.5 kN/m. Determine the maximum bending stress induced in the beam?

2) A beam of triangular cross-section having base width 100 mm & height 150 mm is subjected to a shear force of 13.5 kN. Find the value of τmax & sketch the shear stress distribution along depth of beam?

3) A cantilever beam of rectangular cross-section 60 x 30 mm and 2 m long carrying a point load of 5 kN at its free end. Determine the maximum bending stress induced in the beam?

4) Derive an expression for shear stress at a point in the transverse section of a circular cross-section subjected to a shear force?

5) A bar of rectangular cross-section 60mm wide and 40mm thick is subjected to a pull of 96 kN which acts parallel to the axis of the bar and in the centre of the width but at a distance 5mm from the centre in the direction of the thickness. Calculate the extreme values of the stress and draw a diagram showing the variation of the stress across the section.

UNIT-IV

1) What power could be transmitted at 300rpm by a hollow steel shaft of 7.5cm external diameter and 5cm internal diameter when the permissible shear stress for the steel is 50N/ mm^2 and the maximum torque is 1.3times the mean? Compare the strength of hollow shaft with that of a solid shaft of same material, weight and length.

2) A closed coil helical spring of 10cm mean diameter is made up of 1cm diameter rod and has 20 turns. The spring carries an axial load of 300N.Determine the maximum shearing stress taking the value of modulus of rigidity as $0.80x10^5$ N/ mm^2. Determine the deflection when carrying this load. Also calculate the stiffness of the spring.

3) Design a suitable diameter for a circular shaft required to transmit 90kW at 180rpm.Theshear stress in the shaft is not to exceed 70N/ mm^2 and the maximum torque exceeds the mean by 40%. Also calculate the angle of twist in a length of 2m.Take C= $0.8x10^5$N/mm^2.

4) A closed coiled spring is made up of 10mm diameter steel rod. The coil consists of 10 complete turns with a mean diameter of 120mm.The spring carries an axial load of 200N.Find the maximum shear stress induced in the rod. If C =80Gpa. find the deflection of the spring. the stiffness and strain energy stored in the spring.

5) A solid circular shaft transmits 75kW at 200 rpm. Calculate the shaft diameter. if the twist in the shaft is not to exceed 1^0 in 2m length of shaft and shear stress is limited to 50Mpa and maximum torque is 10% more than the mean torque. N= 100 Gpa.

6) A closed coiled helical spring is made of 8mm diameter wire. The mean diameter of the coil is 100mm and the number of turns is 16.The Modulus of Rigidity of the

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SATHYABAMA UNIVERSITY
(UNDER SECTION 3 OF UGC ACT,1956)
DEPARTMENT OF CIVIL ENGIEERING
(20302)MECHANICS OF SOLIDS -1
QUESTION BANK

UNIT – I

PART A

1. Define Stress.
2. Define Strain
3. State Hooke's law.
4. Define factor of safety.
5. State tensile stress and tensile strain.
6. Define Shear stress.
7. Define modulus of rigidity.
8. State Bulk modulus.
9. Give the relationship between Bulk modulus and Young's modulus.
10. Give the relationship between the three moduli of elasticity.

PART B

1. A rod 200cm long and of diameter 3cm is subjected to an axial pull of 30KN.If the young's modulus of the material of the rod is $2x10^5$ N/mm^2.Determine i) Stress ii) Strain iii)Elongation of the rod.

2. Find the young's modulus of the rod of diameter 30mm and of length 300mm which is subjected to a tensile load of 60KN and the extension of the rod is equal to 0.4mm

3. A rod circular in section tapers from 20mm diameter at one end to 10mm diameter at the other end and is 200mm long.On applying an axial pull of 6000N,it was found to extend by 0.068mm.Find the young's modulus of the maferial of the rod.

4. For a given material the young's modulus is 1.1x10N/mm^2 and the modulus of rigidity is $0.43x10^5$N/mm^2.Find the bulk modulus and the lateral contraction of a round bar of 40mm diameter and 2.5m length when strecthed by 2.5mm.

5. A bar of 30mmdiameter is subjected to a pull of 60KN.The measured extension on a guage length of 200mm is 0.09mm and change in diameter is 0.0039.Calculate the poisson's ratio and the values of the three moduli.

6. A reinforced concrete column is 400x400mm and is provided with 8 bars of 22mm diameter.Find the safe axial load on the column if the maximum stress in concrete is limited to 4N/mm^2.

UNIT- II

PART A

1. How are beams classified based on supports?
2. What is meant by a Simply Supported beam?
3. Define Shear force.
4. Define Bending moment at a section.
5. What is meant by positive or saggging bending moment?
6. List the different types of tranverse loads.
7. Draw the Shear force and Bending moment diagram for a cantilever beam of length 'L' carrying a point load W at the free end.
8. Draw the shear force and Bending moment diagram for a simply supported beam of length L subjected to a central point load 'W'.
9. Draw the S.F.D and B.M.D for the simply supported beam of length 'L'subjected to UDL of w/m length throughout its length.
10. When will the Bending moment be maximum?

PART B

1. A cantilever beam of length 5m carries point loads of 3KN,4KN and 6KN at 0,2, and 3.5m from the free end.Draw the SFD and BMD for the cantilever.

2. A Cantilever of length 4m carries a UDL of 3KN/m over the whole length.Draw the SFD and BMD.

3. A cantilever of length 1.5m carries a UDL of 4KN/m run over a length of 1m from the free end.Draw the SFD and BMD.

4. A simply supported beam of 5m long supported at the ends carries point loads of 140KN,60KN and 80KN at distances 0.5m,2.5m and 3.5m respectively from the left support. Draw the SFD and BMD and find the position of maximum Bending moment.

5. A simply supported beam of 4m span carries a uniformly distributed load of 3KN/m over the whole length of the beam.Draw the SFD and BMD.

6. A beam AB,20m long is supported at the right hand end B and at an intermediate point C,4m from A so that BC=16m.It carries two concentrated loads, one of 4.8KN at A and another of 8KN at E which is at

a distance of 4m from B.In addition, the beam carries a UDL of 16KN/m run over its entire length and also another of 10KN/m run over the length CD,where CD=6m and BD=10m.Draw the SFD and BMD for the overhanging beam.

UNIT-III

PART A

1. List the types of stresses are caused in a beam subjected to a constant shear force.
2. State any two assumptions while deriving the general formula for shear stresses.
3. Define shear stress distribution.
4. Write down the expression for the shear stress distribution in a beam subjected to shear force F.
5. Write the formula to find the shear stress distribution for a rectagular beam section and sketch the shear stress distribution.
6. What is the ratio of maximum shear stress to the average shear stress for the rectangular section?
7. Draw the shear stress distribution for a solid circular section.
8. What is the ratio of a maximum shear stress to the average shear stress in the case of solid circular section.
9. Sketch the shear stress distribution in a beam made of hollow circular section.
10. What is the maximum value of shear stress for triangular section?

PART B

1. A timber beam 120mm wide and 180mm deep has a span of 5m.Calculate the maximum shear stress produced by a load of 5KN.

2. A hollow beam of square section of outside width 130mm and the thickness of material 30mm.Calculate the maximum intensity of shear stress and sketch the distribution of shear stress across the section ,if the Shear force at the cross section being 210KN.

3. A 350mmx125mm I girder has 30mm thick flanges and 20mm thick web subjected to a shearing force of 145KN. Calculate the maximum intensity of shear stress and sketch the distribution of shear stress across the section. Calculate the percentage shear force carried by the web.

4. A beam of T-section with flange 400mmx35mm and web 320mm x35mm is subjected to a shear force of 85KN.Find the maximum intensity of shear stress and sketch the distribution of stress across the section.

5. A beam of triagular section with base 330mm and height 290mm is used with the base horizontal.Calculate the intensity of maximum shear stress and plot the variation of shear stress along the section.

6. A rectangular beam 100mm wide and 250mm deep is subjected to a maximum shear force 50 KN.Determine i) Average shear stress ii)maximum shear stress and iii)Shear stress at a distance of 25 mm above the neutral axis.

UNIT-IV

PART A

1. Define Torsion.
2. Give any two assumptions made in torsion equation.
3. Write the Torsional equation.
4. Write the expression for the power transmitted by a shaft.
1. Write the expression for the power transmitted by a hollow shaft.
2. Define polar modulus.
3. Why hollow shafts are preferred when compared to solid circular shafts?
4. Define Torsional Rigidity.
5. Classify Springs.
6. Define Stiffness.Write the formula for the stiffness of a close coiled helical spring subjected to axial load.

PART B

1. A solid circular shaft is required to transmit 95KW at 150 r.p.m. Find out the diameter of the shaft if permissible shear stress is 60Mpa and the angle of twist is 0.30 per metre length.Take C=1x105N/mm^2.

2. A hollow shaft is to transmit 300KW at 100 r.p.m.If the shear Stress is not to exceed 60N/mm^2 and the internal diameter is 0.6 times the external diameter.Find the internal and external diameters of the shaft. The maximum torque exceeds the mean by 10%

3. A solid shaft is to transmit 300KW at 100 r.p.m if the shear stress is not to exceed 80N/...... ...d the diameter of the shaft.If this shaft were to be replaced by hollow shaft of same material and length with an internal diameter of 0.6times the external diameter, what percentage saving in weight is possible?

4. A close coiled helical spring made of 5mm diameter wire has 16 coils of 100mm inner diameter.If the maximum shear stress is limited to 150Mpa.Find the stiffness of the spring.Take G=85Gpa

5. A close coil helical Spring of round steel wire 10mm in diameter has a mean radius of 120mm.The spring has 10 complete turns and is subjected to a axial load of 200N. Determine i)Deflection of the spring ii)Maximum shear stress in the wire and iii) stiffness of the spring.G=80N/mm^2.

6. A closely coiled helical spring of round steel wire 5mm in diameter having 12 complete coils of 50mm mean diameter is subjected to an axial load of 100KN.Find the deflection of the spring and maximum shering stress in the material.Modulus of rigidity N=80KN/mm^2.

UNIT-V

PART A

1. Define resilience and modulus of resilience.
2. Give the expression for calculating strain energy.
3. The maximum stress intensity due to suddenly applied load is ________that of gradually applied load.
4. Explain plastic and elastic materials.
5. What is a rigid material?
6. What is meant by stability?
7. Define strain energy density.
8. Give the relation for change in length of a bar hanging freely under its own weight.
9. Give the expression for strain energy stored in a body when load is applied gradually.
10. Give the expression for strain energy stored in a body when the load is applied suddenly.

PART B

1. A steel bar 20mm diameter is pulled axialy by a force of 15KN.If the bar is 400mm long, calculate the strain energy stored per unit volume of the bar and total strain energy stored by the bar.Take E=2x10^5 N/mm^2.

2. Two bars of length L and of the same material are subjected to the same axial tensile force P. The first bar has uniform diameter 2d and the second bar has diameter d for the length L/3 and a diameter 2d for the remaining length.Compare the strain energies for the two bars.

3. A weight of 20KN falls by 40mm on a collar rigidly attached to a vertical bar 5000mm long and $2000mm^2$in section.Find the instantaneous expansion of the bar.Take E=310Gpa.

4. A load of 150N falls by gravity of vertical distance of 4m,when it is suddenly stopped by a collar at the end of a vertical rod of length 50cm and diameter 30mm.The top of the bar is rigidly fixed to a ceiling. Calculate the maximum stress and strain induced in the bar.Take $E=2x10^5N/mm^2$.

5. A 20mm diameter mild steel bar of length 1.5m is stressed by a weight of 200N dropping freely through 20mm before commencing to stretch the bar.Find the maximum instataneous stress and elongation produced in the bar.Take $E=2x10^5N/mm^2$.

6. A unknown weight falls through 10mm on a collar of rigidly attached to the lower end of a vertical bar 3m long and $600mm^2$ in section.If the maximum instantaneous extension is known to be 2mm,what is the corresponding stress and the value of the weight?