Code : 021306

B.Tech 3rd Semester Exam., 2017

STRENGTH OF MATERIAL

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer of the following (any *seven*) : 2×7=14

(a) The ratio of lateral strain to linear strain is known as

(i) modulus of elasticity

(ii) modulus of rigidity

(iii) Poisson's ratio

(iv) elastic limit

(b) The temperature strain in a bar is _____ proportional to the change in temperature.

(i) directly

(ii) indirectly

(iii) Either *(i)* or *(ii)*

(iv) None of the above

(c) Moment of inertia of a semi-circle about its *XX*-axis is given by

(i) $0{\cdot}22r^3$

(ii) $0{\cdot}11r^4$

(iii) $0{\cdot}14r^4$

(iv) $0{\cdot}2r^4$

(d) The strength of the beam mainly depends on

(i) bending moment

(ii) c.g. of the section

(iii) section modulus

(iv) its weight

(e) A cantilever beam *AB* of length *l* has moment *M* applied at free end. Th deflection at the free end *B* is given as

(i) M^2l/EI

(ii) $Ml^2/2EI$

(iii) $Ml/2EI$

(iv) $Ml^3/2EI$

(f) A beam of length 6 m carries a point load 120 kN at its centre. The beam is fixed at both ends. The fixing moment at the ends is

(i) 40 kNm

(ii) 90 kNm

(iii) 120 kNm

(iv) 150 kNm

(g) Which of the following are usually considered as thin cylinders?

(i) Boilers

(ii) Tanks

(iii) Water pipes

(iv) All of the above

(h) Thin cylinders are frequently required to operate under pressure up to

(i) $5\ MN/m^2$

(ii) $15\ MN/m^2$

(iii) $30\ MN/m^2$

(iv) $250\ MN/m^2$

(i) In thick cylinders, the radial stress in the wall thickness

(i) is zero

(ii) is negligibly small

(iii) varies from the inner surface to the outer surface

(iv) Any of the above

(j) The stress due to suddenly applied load is _____ times that of gradually applied load.

(i) two

(ii) three

(iii) four

(iv) five

2. (a) A steel bar is 900 mm long, its two ends are 40 mm and 30 mm in diameter and the length of each rod is 200 mm. The middle portion of the bar is 15 mm in diameter and 500 mm long. If the bar is subjected to an axial tensile load of 15 kN, find its total extension, assuming $E = 200\ GN/m^2$. 7

(b) The following data relate to a bar subjected to a tensile test :

Diameter of bar = 30 mm

Tensile load = 54 kN

Gauge length = 300 mm

Extension of the bar = 0·112 mm

Change in diameter = 0·00366 mm

Calculate the Poisson's ratio and the values of three moduli. 7

3. Two mutually perpendicular planes of an element of material are subjected to direct stresses of 10·5 MN/m^2 (tensile) and 3·5 MN/m^2 (compressive) and shear stress of 7 MN/m^2. Using both analytical and graphical methods, find—

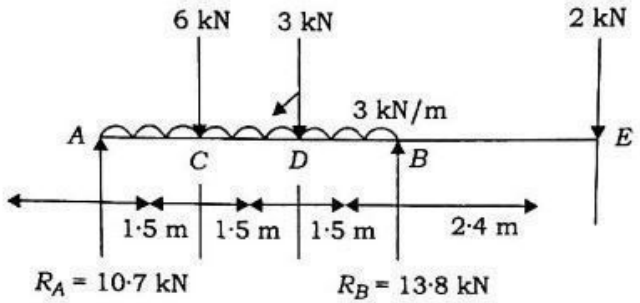
(a) the magnitude and direction of principal stresses;

(b) the magnitude of the normal and shear stresses on a plane on which the shear stress is maximum. 14

4. *(a)* With the help of suitable assumptions, deduce torsion equation for a hollow circular shaft. 6

(b) A hollow circular shaft 20 mm thick transmits 294 kW at 200 r.p.m. Determine the diameters of the shaft if the shear strain due to torsion is not to exceed $8·6 \times 10^{-4}$. Assume modulus of rigidity as 80 GN/m^2. 8

5. The following figure shows a loaded beam :



(a) Sketch the shear force and bending moment diagrams giving the important numerical values.

(b) Calculate the maximum bending moment and the point at which it occurs. 14

6. *(a)* A cantilever of length l carries a uniformly distributed load of W per unit run for a distance $\frac{3}{4}l$ from the fixed end.

Find the slope and deflection at the free end. 7

(b) A cantilever of length l carries a point load W at the end. If the moment of inertia of the section increases uniformly from I at the free end to $2I$ at the fixed end, calculate the deflection at the free end. 7

7. *(a)* Calculate the change in dimensions of a thin cylindrical shell due to an internal pressure. Also calculate the change in length and diameter of the cylindrical shell. 7

(b) A cylindrical shell 3 m long which is closed at the ends has an internal diameter of 1 m and a wall thickness of 15 mm. Calculate the circumferential and longitudinal stresses induced and also change in dimensions of the shell if it is subjected to an internal pressure of $1{\cdot}5\ MN/m^2$. Take $E = 200\ GN/m^2$ and $1/m = 0{\cdot}3$. 7

8. *(a)* Discuss and derive Lame's theory for thick shells. 7

(b) Calculate the thickness of metal necessary for a cylindrical shell of internal diameter 160 mm to withstand a pressure of $25\ MN/m^2$, if maximum permissible tensile stress is $125\ MN/m^2$. 7

(Turn Over)

Code : 021306

2012

STRENGTH OF MATERIAL

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

1. Choose the correct answer/Answer the following (any *seven*) : 2×7=14

(a) A metallic bar firmly restrained at ends, on rise in temperature develops

(i) shear stress

(ii) compressive stress

(iii) tensile stress

(iv) no stress

(b) In a state of uniaxial stress, the angle made by normal to the plane of maximum shear stress with the direction of applied load is

(i) 90°

(ii) 60°

(iii) 45°

(iv) 0°

(c) If Poisson's ratio for the material is 0·5, then the elastic modulus of the material is

(i) three times its shear modulus

(ii) two times its shear modulus

(iii) equal to shear modulus

(iv) indeterminate

(d) Define resilience.

(e) Couples applied to a beam

(i) affect the SF

(ii) affect the BM

(iii) affect both SF and BM

(iv) None of the above

(f) Which of the following is correct in the context of two shafts connected in parallel?

(i) Same torque

(ii) Same angle of twist

(iii) Same torsional stiffness

(iv) None of the above

(g) Define flexural rigidity.

(h) In a thin cylindrical shell closed at ends and experiencing internal fluid pressure, the ratio of hoop stress and longitudinal stress is

(i) 4 : 1
(ii) 3 : 1
(iii) 2 : 1
(iv) 1 : 2

(i) The expression $EI\frac{d^4y}{dx^4}$ at a section of a member represents

(i) rate of loading
(ii) shear force
(iii) bending moment
(iv) slope

(j) The shear stress required to cause plastic deformation of solid metal is called

(i) proof stress
(ii) rupture stress
(iii) ultimate stress
(iv) flow stress

2. (a) What are composite bars? What are equilibrium and compatibility equations?

(b) Three long parallel wires equal in length and in the same plane are supporting a rigid bar connected at their bottom as shown in Fig. 1. The middle wire is of steel while the other two are of brass. All the wires are of 100 mm^2 cross-sectional area. The rigid bar supports a u.d.l. as shown. Determine the forces in and elongation of wires. [$E_s = 210\ GN/m^2$, $E_b = 100\ GN/m^2$.] 10

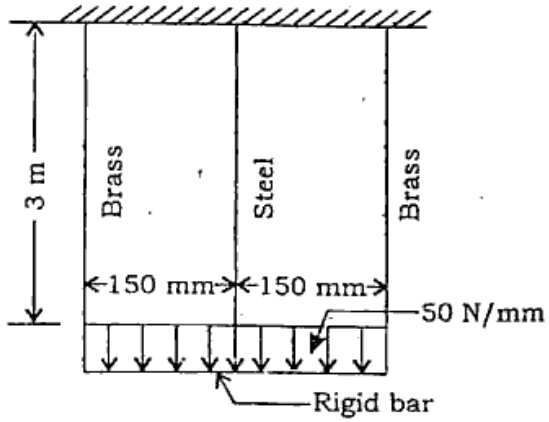


Fig. 1

3. (a) An MS bar 400 mm in diameter and 2000 mm long is subjected to a shearing force of 100 kN. Determine the shear force setup (i) when the force is applied at right angles to the length of the bar and (ii) when the force is applied along the longitudinal axis of the bar. 5

(Continued)

(b) An axial tensile force of 100 kN is applied to a steel rod, 38 mm in diameter and 500 mm long. Calculate the change in volume if $E = 200$ GPa and Poisson's ratio is 0·25. 9

4. Draw the shear force and bending moment diagram for the beam loaded as shown in Fig. 2. Determine (a) the position of maximum bending moment and (b) the position of point of contraflexure, if any. 14

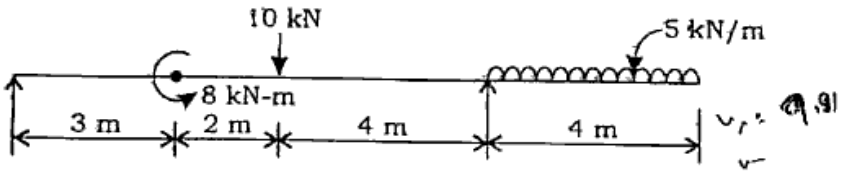


Fig. 2

5. (a) Define the following : 4

(i) Torsional rigidity

(ii) Strength of a shaft

(b) A hollow steel shaft, 200 mm internal diameter and 300 mm external diameter is to be replaced by a solid alloy shaft. If the polar modulus has the same value for both, calculate the diameter of the solid shaft and the ratio of torsional rigidities. [G for steel = 2·5 × G for alloy.] 10

(Turn Over)

6. (a) What is Macaulay's method of beam deflection? What are its advantages over the double integration method? 4

(b) A cantilever of 4 m span and 400 mm depth carried a uniformly distributed load of 5 kN/m. Find the value of the concentrated load w acting at the free end so that the maximum deflection does not exceed 10 mm anywhere in the cantilever. Also find the maximum slope due to both these loads. [$E = 200$ GN/m^2; $I = 20000 \times 10^4$ mm^4.] 10

7. (a) How do you distinguish between thin and thick cylindrical shells? What are the stresses developed in thin and thick cylindrical shells? 5

(b) A thick cylindrical shell of 80 mm inside diameter is subjected to an internal fluid pressure of 30 MPa. Determine the thickness of the shell if the permissible tensile stress is 75 MPa. 9

8. (a) An element of a strained body is subjected to two dimensional stresses. Prove that the sum of the normal components of stresses on any two mutually perpendicular planes is constant. 4

(b) A plane element is subjected to the state of stresses $\sigma_x = -75$ MPa, $\sigma_y = 100$ MPa, $\tau_{xy} = \tau_{yx} = 50$ MPa. Determine the—

(i) principal stresses and their directions;

(ii) maximum shearing stresses and corresponding planes;

(iii) normal and tangential stresses in a plane inclined at 30° to the axis of major principal stress. 10

9. (a) Derive expressions for the strain energy in a material subjected to (i) a uniform tensile stress, (ii) a uniform shearing stress and (iii) a torsional stress. 6

(b) Using Castigliano's theorem, find the maximum deflection of a simply supported beam subjected to u.d.l. over its entire span. Assume *EI* constant. 8

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Code : 021306

B.Tech 3rd Semester Exam., 2013

STRENGTH OF MATERIALS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer any seven sub-questions (select correct answer/fill in the blanks/give short answer) : 7×2=14

(a) The total area under the stress-strain curve of a mild steel specimen test up to failure under tension is a measure of its

(i) breaking strength

(ii) hardness

(iii) stiffness

(iv) toughness

(b) A bar of copper and steel form a composite system. They are cooled to a temperature of 25 °C. What type of stress is induced in the copper bar?

(i) Tensile

(ii) Compressive

(iii) Shear

(iv) Tensile as well as compressive

(c) The planes of maximum normal stresses are inclined at an angle of 45° degree to the plane of pure shear.

(d) A shaft is to be designed on the basis of

(i) maximum allowable shear stress

(ii) maximum allowable angle of twist

(iii) both *(i)* and *(ii)*

(iv) torsional rigidity

(e) In a simply supported beam carrying a uniformly distributed load over its entire span, slope is maximum at

(i) mid span

(ii) supported ends

(iii) $\frac{l}{4}$ from either end

(iv) $\frac{l}{3}$ from either end

(f) The shape of the bending moment diagram for a cantilever beam carrying a uniformly distributed load is

(i) a straight line

(ii) an ellipse

(iii) a hyperbola

(iv) a parabola

(g) In a thin cylinder, the ratio of hoop stress to longitudinal stress is

(i) $\frac{1}{4}$ (ii) $\frac{1}{2}$

(iii) 2 (iv) 4

(h) Maximum normal stress theory is used for

(i) brittle materials

(ii) ductile materials

(iii) both ductile and brittle

(iv) None of the above

(i) Define strain energy of a material.

(j) Define factor of safety of ductile material.

2. (a) Define the principle of superposition. What is its utility? 4

(b) A load of 1000 kN is applied to a reinforced concrete column of 600 mm diameter which has four steel rods of 40 mm diameter embedded in it. Determine the stress in the concrete and the steel. Take E for steel = 200 GPa and E for concrete = 15 GPa. Also find the adhesive force between the concrete and the steel. 10

3. (a) Derive a relation between Young's modulus, modulus of rigidity and the Poisson's ratio. 6

(b) An axial tensile load of 60 kN is applied to a bar of 40 mm diameter and 1·2 m length. The extension of the bar is measured to be 0·275 mm, where the reduction in diameter is 0·004 mm. Calculate Poisson's ratio and the values of the three moduli. 8

4. Draw the shear force and bending moment diagrams for the beam as shown in Fig. 1. Locate the point of contraflexure if any : 14

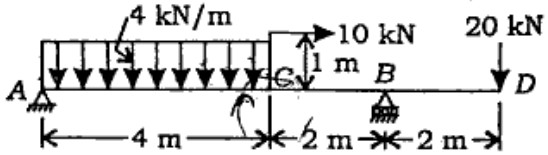

Fig. 1

5. (a) State and prove the moment-area moment. 6

(b) Determine the maximum deflection of a simply supported beam of 5 m length and carries a load which varies uniformly from 15 kN/m at one end to 60 kN/m at the other. $EI = 2$ MN-m^2. 8

6. A freely rotating shaft $ABCDE$ as shown in Fig. 2 is suitably supported at A and D. The shaft is required to transmit power through belt pulley system. 300 kW is input at pulley B while 120 kW and 180 kW are taken

(Continued)

out through pulley C and E respectively. If the shaft frequency is 32 Hz, $G = 75$ GPa, allowable shear stress for the shaft material is 50 MPa and allowable angle of twist is 4°, determine the diameter of the shaft. 14

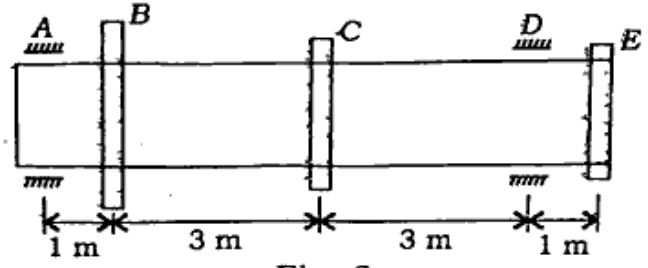

Fig. 2

7. *(a)* What do you mean by plane stress? Discuss the situation with example.

(b) The state of stress at a point is shown in Fig. 3.

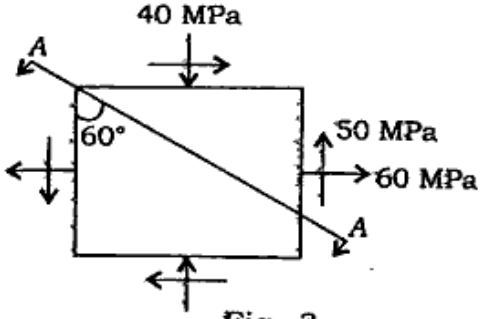

Fig. 3

Determine—

(i) the principal stresses, maximum shear stress and its inclination;

(ii) normal and shearing stress at the two plane *A-A* which makes 60° with the axis.

14

8. *(a)* Show that the volumetric strain of a thin cylindrical shell is the sum of longitudinal strain and twice of hoop strain. 4

(b) The maximum permissible stress in a thick cylinder of 500 mm diameter and of 100 mm thickness is 15 MPa. Find the maximum allowable internal and external pressures on the cylinder, when applied separately. 10

9. *(a)* Develop an expression for strain energy in a shaft subjected to torsion and show that the maximum strain energy in the shaft is twice the total strain energy. 6

(b) Calculate the total elongation of the bar *ABC* by applying Castigliano's theorem, $E = 70 \times 10^3$ MPa, as shown in in Fig. 4. 8

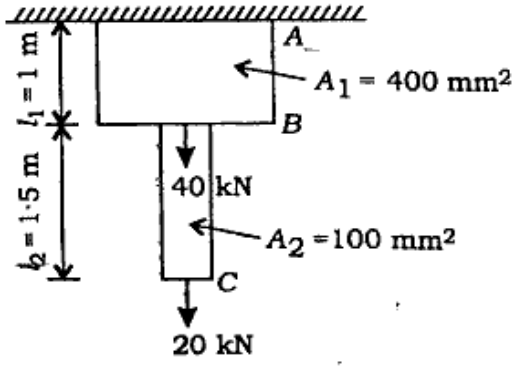

Fig. 4

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Code : 021306

B.Tech 3rd Semester Exam., 2015

STRENGTH OF MATERIAL

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct alternative of the following (any *seven*) : 2×7=14

(a) The Young's modulus E, shear modulus G and Poisson's ratio μ are related by

(i) $E = 2G(1-\mu)$

(ii) $E = 2G(1+2\mu)$

(iii) $E = 2G(1+\mu)$

(iv) None of the above

(b) The maximum deflection of a simply supported beam of length l with central concentrated load W is

(i) $\frac{Wl^2}{48EI}$ *(ii)* $\frac{Wl^2}{24EI}$

(iii) $\frac{Wl^3}{48EI}$ *(iv)* $\frac{Wl^2}{8EI}$

(c) A circular shaft of length l subjected to a torque T, G is rigidity modulus and j is polar moment of inertia, then the total angle of twist is given by

(i) $\frac{Tl}{GJ}$

(ii) $\frac{TJ}{Gl}$

(iii) $\frac{TG}{Jl}$

(iv) $\frac{GJ}{Tl}$

(d) In a two-dimensional problem, the principal stresses at a point are σ_1 and σ_2. The normal stress associated with the plane of maximum shear is

(i) $\frac{\sigma_1+\sigma_2}{2}$

(ii) $\frac{\sigma_1-\sigma_2}{2}$

(iii) zero

(iv) None of the above

(e) The maximum normal stress theory is used for

(i) ductile material

(ii) brittle material

(iii) viscoelastic material

(iv) None of the above

(f) A material having identical properties in all directions is called

(i) elastic

(ii) homogeneous

(iii) isotropic

(iv) Any of the above

(g) A cantilever beam is loaded uniformly throughout its length. The shape of shear force diagram will be

(i) a right-angled triangle

(ii) an isosceles triangle

(iii) a rectangle

(iv) None of the above

(h) The stresses on thick cylinder subjected to uniform pressure vary proportionally to

(i) r

(ii) $\frac{1}{r}$

(iii) r^2

(iv) $\frac{1}{r^2}$

(i) Castigliano's theorems are valid for

(i) elastic structure

(ii) truss

(iii) beam

(iv) linear structure

(j) Point of contraflexure is, where

(i) bending moment is maximum

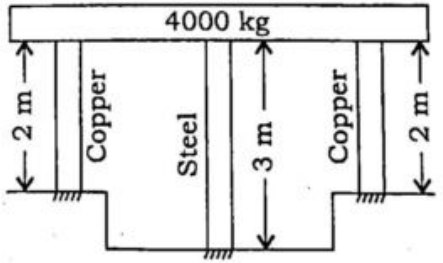
(ii) shear force is maximum

(iii) shear force is zero

(iv) bending moment is zero

2. (a) Give the governing principle of stress for composite member. 7

(b) Two copper rods and one steel rod each of 2·5 cm diameter together support a load of 4000 kg. Find the stresses on each rod. Take E, Young's modulus of steel and copper as 2×10^6 kg/cm^2 and $1{\cdot}1\times10^6$ kg/cm^2 respectively. 7



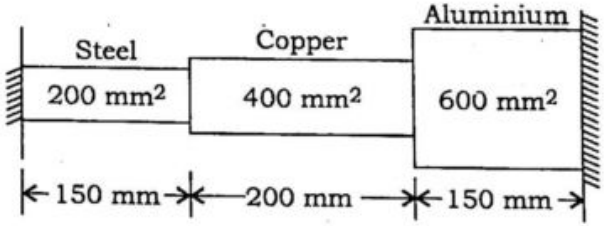
3. (a) Explain Poisson's ratio. 7

(b) A rod is composed of three segments. Find the stresses developed in each material when temperature of the system is raised by 55 °C. Use

$E_S = 2\times10^5$ N/mm^2, $\alpha_S = 1{\cdot}2\times10^{-5}$/°C,

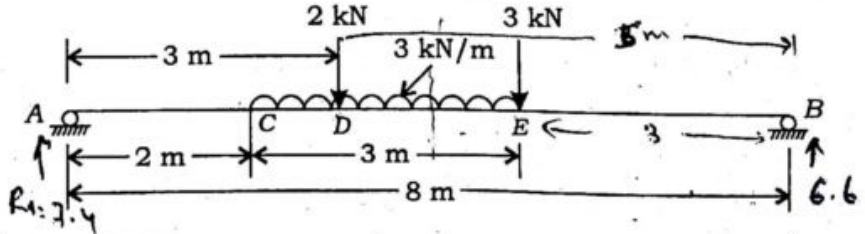
$E_C = 1\times10^5$ N/mm^2, $\alpha_C = 1{\cdot}75\times10^{-5}$/°C,

$E_A = 0{\cdot}7\times10^5$ N/mm^2, $\alpha_A = 2{\cdot}2\times10^{-5}$/°C 7



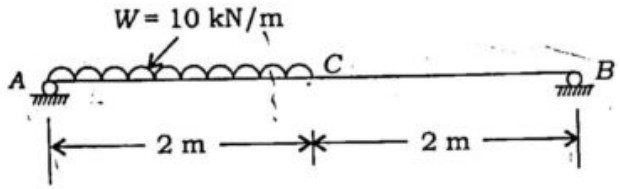
4. A solid shaft is required to transmit 750 kN at 60 r.p.m. If the maximum value of shear stress is not to exceed 50 N/mm^2, calculate the diameter of the shaft. If this shaft is replaced by a hollow shaft of diameter ratio 0·6, what will be the percentage of saving? The torque, maximum shear stress, material and length of shafts are same in either case. 14

5. Draw the shear force and bending moment diagrams of the following beam : 14



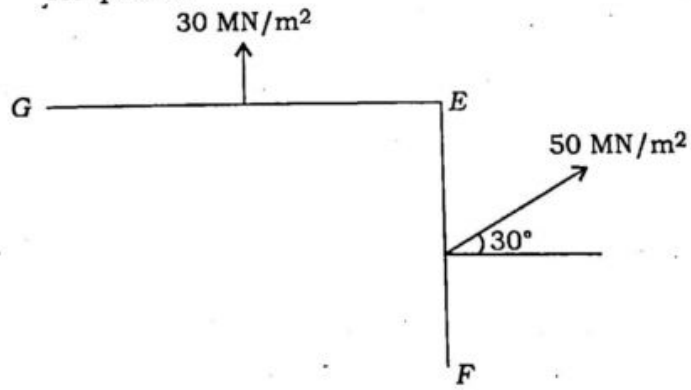
6. (a) What is modified double-integration method? 4

(b) Find the maximum deflection for the following beam. Moment of inertia $I = 78{\cdot}5\times10^{-6}$ mm^4, Young's modulus $E = 2\times10^4$ N/mm^2 : 10



7. (a) Explain plane stress condition. 4

(b) Find the resultant stress on plane *GE*. Also determine the principal stress and its plane. 10



8. Calculate the thickness of metal for a thick cylindrical shell of internal diameter 160 mm to withstand and internal pressure of 25 MN/m^2 at the maximum permissible tensile stress as 125 MN/m^2. 14

9. *(a)* What is proof resilience? 4

(b) Two elastic bars of same material and length but one of circular cross-section of diameter 30 mm and other square cross-section of side 30 mm absorb same amount of strain energy, delivered due to gradually applied axial forces. Calculate the ratio of induced stresses applied. Also calculate the ratio of applied forces. 10

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Code : 021306

B.Tech 3rd Semester Examination, 2016

Strength of Material

me : 3 hours *Full Marks : 70*

structions :

(i) There are Nine Questions in this Paper.

(ii) Attempt Five questions in all.

*(iii) **Question No. 1 is Compulsory.***

(iv) The marks are indicated in the right hand margin.

Choose the correct answer of the following (any seven): 2×7=14

(a) A localised compressive stress at the area of contract between two members is known as:

(i) Shear

(ii) Crushing

(iii) Bending

(iv) Tensile

(b) In case of a circular section the section modulus i given as:

(i) $\pi d^2/16$

(ii) $\pi d^3/16$

(iii) $\pi d^3/32$

(iv) $\pi d^4/64$

(c) For no tension in the section, the eccentricity must not exceed:

(i) k^2/d

(ii) $2k^2/d$

(iii) $4k^2/d$

(iv) $k/\sqrt{d}$

(d) The slope and deflection at the section in a loaded beam can be found out by which of the following methods?

(i) Double integration method

(ii) Moment area method

(iii) Macaulay's method

(iv) Any of the above

(e) A cantilever of length 1 is carrying a uniformly distributed load of *w* per unit run over the whole span. The deflection at the free end is given as:

(i) $W1^3/4EI$

(ii) $W1^2/4EI$

(iii) $W1^4/8EI$

(iv) $W1^4/16EI$

(f) A beam of length 4 m, fixed at both ends carries a point load 120 kN at the centre. If EI for the beam is 20000 kNm^2, deflection at the centre of the beam is:

(i) 1 mm

(ii) 2 mm

(iii) 5 mm

(iv) 10 mm

(g) Pressure vessels are made of:

(i) Non-ferrous materials

(ii) Sheet steel

(iii) Cast iron

(iv) Any of the above

(h) In thick cylinders the variation in the radial as well as circumferential stress across the thickness is obtained with the help of:

(i) Clapeyron's Theorem

(ii) Castigliano Theorem

(iii) Lame's Theorem

(iv) None of the above

(i) The strength of a hollow shaft for the same length, material and weight is _____ a solid shaft:

(i) Less than

(ii) More than

(iii) Equal than

(iv)None of the above

(j) In case of a solid shaft strain energy in torsion, per unit volume is equal to:

(i) $\tau^2 / 2C$

(ii) $\tau^2 / 4C$

(iii) $\tau^2 / 6C$

(iv) $\tau^2 / 8C$

2. (a) A rod of length "1" tapers uniformly from diameter d_1 to a diameter d_2. Its wider end is fixed and lower end is subjected to an axial tensile load P. Calculate the elongation in case of above taper rod. 7

(b) A bar of steel is 60 mm* 60 mm in section and 180 mm long. It is subjected to a tensile load of 300 kN along the longitudinal axis and tensile loads of 750 kN and 600 kN on the lateral faces. Find the change in the dimensions of the bar and change in the volume. Take E=200 GN/m^2 and 1/m=0.3. 7

3. Draw the Mohr's stress circle for the direct stresses of 65 MN/m^2 (tensile) and 35 MN/m^2 (compressive) and estimate the magnitude and direction of the resultant stresses on the planes making angles of 20° and 65° with the plane of the first principal stress. Find also the normal and tangential stresses on these planes. 14

4. (a) What is shaft Couplings ? 4

(b) A solid steel shaft is subjected to a torque of 45 kNm. If the angle of twist is 0.5° per metre length of the shaft and the shear stress is not allowed to exceed 90 MN/m². find:

(i) Suitable diameter for the shaft, (ii) Final maximum shear stress and angle of twist and (iii) Maximum shear strain in the shaft, assume C=80 GN/m². 10

5. A simple beam with an overhang is supported at points A and B (Figure 1). A uniform load of intensity q=200 lb/ft acts throughout the length of the beam and a concentrated load P=14 k at a point 9 ft. from the left-hand support. The span length is 24 ft. and the length of the overhang is 6 ft. Calculate the shear force V and bending moment M at cross section D located 15 ft. from the left-hand support. 14

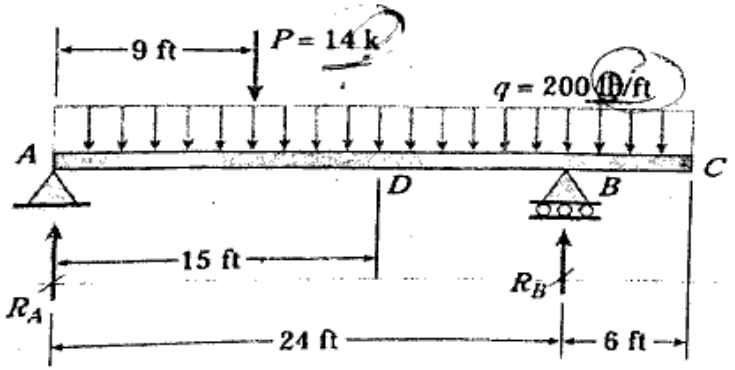

Figure (i) Beam

6. (a) Assuming suitable example discuss "Moment area method" to find the defection of beam. Why Moment area method is more useful as compared to double integration method. 6

(b) A cantilever of length I carrying uniformly distributed load *w* per unit run for a distance 'a' from the fixed end. Calculate deflection at the end of uniformly distributed load and at the end of cantilever. 8

7. (a) Define (i) Hoops stresses (ii) Longitudinal stresses and (iii) Maximum shear stress induced in context to thin shells. 6

(b) A built up cylindrical shell of 300 mm diameter, 3 m long and 6 mm thick is subjected to an internal pressure of 2 MN/m². Calculate the change in length, diameter and volume of the cylinder under that pressure if the efficiencies of the longitudinal and circumferential joints are 80% and 50% respectively. Take E=200 GN/m² and m=3.5. 8

8. (a) Calculate circumferential and radial stress in a thick cylinder assuming internal pressure =P_i and outer surface of cylinder is exposed to atmospheric conditions. 8

(b) A thick cylinder of 150 mm outside radius and 100 mm inside radius is subjected to an external pressure of 30 MN/m² and the internal pressure of 60 MN/m². Calculate the maximum shear stress in the material of the cylinder at the inner radius. 6

9. (a) Consider a solid circular shaft of length l and radius R, subjected to a torque T producing a twist θ in the length of the shaft. Calculate strain energy in torsion. 6

(b) A 1 m long beam rectangular in section 30 mm wide and 40 mm deep is supported on rigid supports at its ends. If it is struck at the centre by a 12 kg mass falling through a height of 60 mm find: (i) The instantaneous stress developed and (ii) The instantaneous strain energy stored in the beam. Take E=200 GN/m². 8

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