

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Strength of Materials

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing one full question from each module.***

Module-1

1 a. State Hooke's law. Derive the expression for change in length of bar using Hooke's law. **(04 Marks)**

b. A steel bar of 25 mm diameter is acted upon by forces as shown in Fig. Q1 (b). Determine the total extension of the bar. $E = 2 \times 10^5$ N/mm^2. **(06 Marks)**

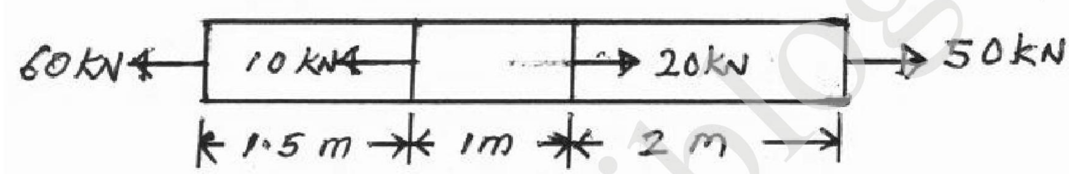

Fig. Q1 (b)

c. The Bronze bar 3 m long with 320 mm^2 cross sectional area is placed between two rigid walls at -20°C. There is a gap $\Delta = 2.5$ mm as shown in Fig. Q1 (c). Find the magnitude and the type of stress induced in the bar when it is heated to a temperature of 50.6°C. For bronze bar take $\alpha_b = 18 \times 10^{-6}/^\circ$C and $E_b = 80$ GPa. **(06 Marks)**

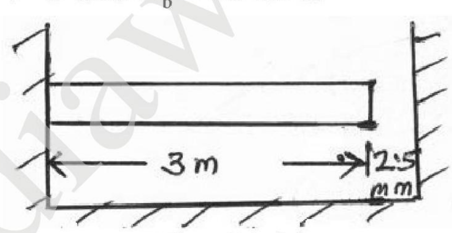

Fig. Q1 (c)

OR

2 a. Derive the relation between modulus of elasticity and modulus of rigidity. **(06 Marks)**

b. Find the total elongation of the bar shown in Fig. Q2 (b) subjected to an axial tensile force of 50 KN on the bar of material having modulus of elasticity $= 2.1 \times 10^5$ N/mm^2. **(04 Marks)**

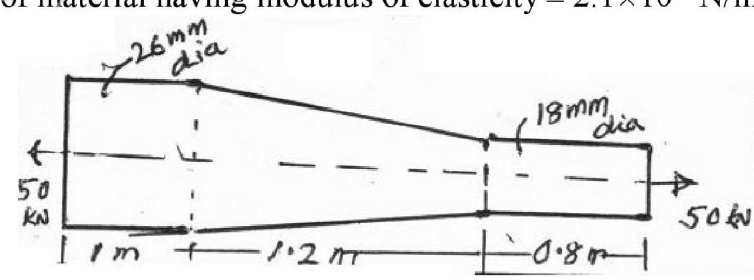

Fig. Q2 (b)

c. A copper rod, 25 mm in diameter is enclosed in steel tube 30 mm internal diameter and 35 mm external diameter. The ends are rigidly attached. The composite bar is 500 mm long and is subjected to an axial pull of 30 KN. Find the stresses induced in the rod and the tube. Take E for steel $= 2 \times 10^5$ N/mm^2 and E for copper as 1×10^5 N/mm^2. **(06 Marks)**

Module-2

3 a. State principal stresses and principal planes. **(04 Marks)**

b. An element is subjected to stresses as shown in Fig. Q3 (b). Find out stresses on inclined plane AB by Mohr's graphical method. **(06 Marks)**

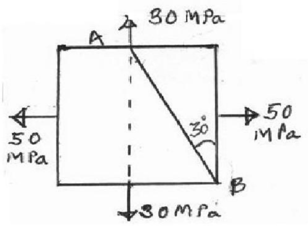

Fig. Q3 (b)

c. A point in a strained material is subjected to the stresses as shown in Fig. Q3 (c). Locate the principal stresses. Also determine the maximum shear stress. Use analytical approach. **(06 Marks)**

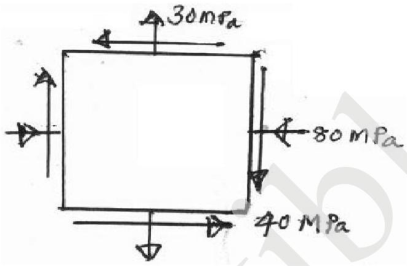

Fig. Q3 (c)

OR

4 a. Differentiate thick and thin cylinders. **(04 Marks)**

b. A cylindrical shell has an external diameter of 500 mm and wall thickness 10 mm. The length of the cylinder is 1.7 m. Determine the increase in its internal diameter and length when inside pressure is 1 N/mm^2. Given E = 210 GPa and Poisson's ratio = 0.3 **(06 Marks)**

c. Draw the radial and hoop stress distribution diagram over the wall of a thick cylinder. The outside diameter of pipe is 150 mm while inside diameter is 70 mm. The pipe is subjected to internal and external pressures 6 MPa and 4 MPa respectively. **(06 Marks)**

Module-3

5 a. Draw SFD and BMD for a simply supported beam carrying udl of intensity ω/m over the entire length. **(04 Marks)**

b. Draw SFD and BMD for a overhanging beam loaded as shown in Fig. Q5 (b). Indicate all salient features. **(12 Marks)**

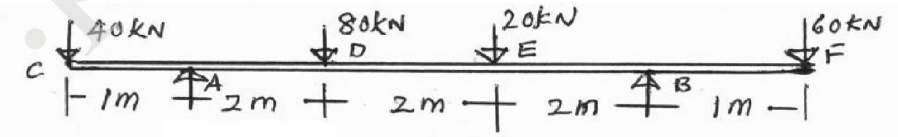

Fig. Q5 (b)

OR

6 a. Derive the relation between load, shear force and bending moment. **(04 Marks)**

b. From the given shear force diagram, shown in Fig. Q6 (b) develop the load diagram and draw BMD. Also determine points of contraflecture if any. **(12 Marks)**

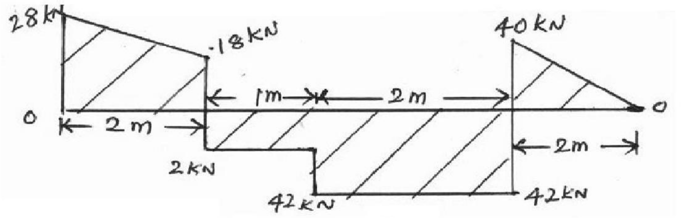

Fig. Q6 (b)

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Module-4

7 a. State the assumptions made in theory of pure bending. Derive bending equation $\frac{M}{I} = \frac{f}{Y} = \frac{E}{R}$ with usual notations. **(06 Marks)**

b. A beam with an I section consists of 180mm × 15mm flanges and a web of 280 mm deep and 15 mm thickness. It is subjected to a bending moment of 120 KN-m and a shear force of 60 kN. Sketch the bending and shear stress distribution along the depth of the section. Refer Fig. Q7 (b). **(10 Marks)**

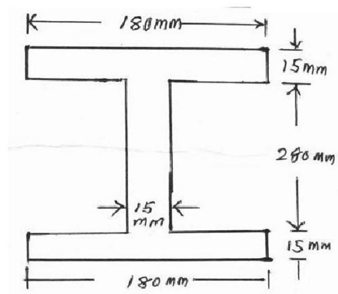


Fig. Q7 (b)

OR

8 a. Derive Euler's expression for buckling load on column with both ends pinned. **(06 Marks)**

b. Design the section of a circular cast iron column to carry a load of 1000 KN. The length of the column is 6 m. Use Rankine's constant $\frac{1}{1600}$ and factor of safety of 3. One end of the column is fixed and other is free. Critical stress is 560 MPa. **(10 Marks)**

Module-5

9 a. With torsional equation explain the following terms :
   (i) Torsional rigidity.
   (ii) Torsional stiffness. **(04 Marks)**

b. With usual notations derive the equation for torsion. **(06 Marks)**

c. A hollow shaft has outer diameter 100 mm and inner diameter 70 mm. Calculate shear stress acting on elements at the outer and inner surfaces, respectively, due to a torque of 7000 N-m. Draw sketch showing how the shear stress vary in magnitude along a radial line. **(06 Marks)**

OR

10 a. Explain the following theories of failure:
   (i) St. Venant's theory.
   (ii) Tresca's theory. **(08 Marks)**

b. At a point in a steel member 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 250 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,
   (i) Maximum shearing stress.
   (ii) Maximum total strain energy.
   (iii) Maximum shear strain energy.

Poisson's ratio = 0.28 **(08 Marks)**

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Strength of Materials

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define : (i) Stress (ii) Strain **(04 Marks)**

b. Derive the expression for elongation of tapering circular bar due to an axial load P. Use standard notations. **(08 Marks)**

c. A circular bar of uniform cross sectional area of 1000 mm^2 is subjected to forces as shown in Fig. Q1 (c). If Young's modulus for the material is 200 GPa, determine the total deformation. **(08 Marks)**

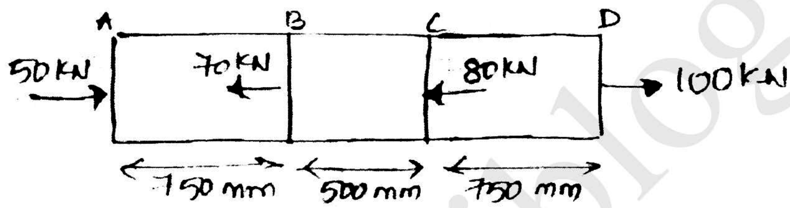


Fig. Q1 (c)

OR

2 a. Derive the relationship between Young's modulus, modulus of rigidity and Poisson's ratio. **(06 Marks)**

b. A bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on guage length of 200 mm is 0.1 mm and change in diameter is 0.004 mm. Calculate (i) Young's modulus (ii) Poisson's ratio (iii) Bulk modulus. **(06 Marks)**

c. A steel rod of 200 mm diameter passes centrally through a copper tube of 50 mm external diameter and 40 mm internal diameter. The tube is closed at each end and the nuts are tightened on the projecting points of rod. If the temperature of the assembly is raised by 50°C. Calculate the temperature stresses developed in copper and steel.

Take $E_S = 200$ GN/m^2; $E_C = 100$ GN/m^2 and $\alpha_S = 12\times10^{-6}$ per °C and

$\alpha_C = 18\times10^{-6}$ per°C. **(08 Marks)**

Module-2

3 a. Define (i) Principal stress (ii) Principal plane **(04 Marks)**

b. Derive expression for normal stress and tangential stress for a member subjected to uniaxial loading. **(06 Marks)**

c. At a point in a strained material, the stresses are as shown in Fig. Q3 (c). Determine the

(i) Principal stress

(ii) Normal and tangential stress on the plane AB.

(iii) Maximum shear stress. **(10 Marks)**

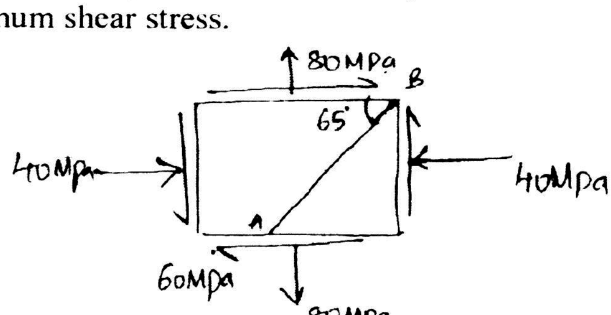


Fig. Q3 (b)

OR

4 a. Derive expression for hoop stress and longitudinal stress for a thin cylindrical vessel subjected to an internal fluid pressure. **(10 Marks)**

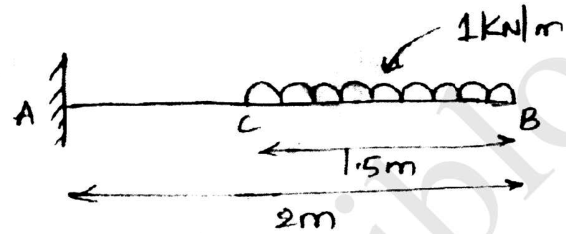
b. Determine the maximum and minimum hoop stress across the section of a pipe of 400 mm internal diameter and 100 mm thick, when the pipe contains a fluid at a pressure of 8 N/mm^2. Also sketch the radial pressure distribution and hoop stress distribution. **(10 Marks)**

Module-3

5 a. Derive the relationship between load intensity, shear force and bending moment. **(08 Marks)**

b. For a simply supported beam subjected to a UDL of intensity W/unit length throughout plot the SFD and BMD and prove that maximum bending moment is $\frac{\omega l^2}{8}$. **(06 Marks)**

c. For the Cantilever beam shown in Fig. Q5 (c), plot the SFD and BMD.

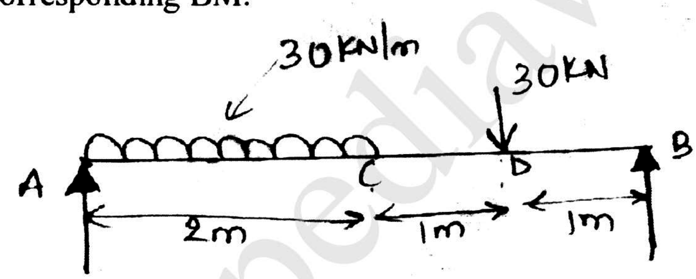


(06 Marks)

Fig. Q5 (c)

OR

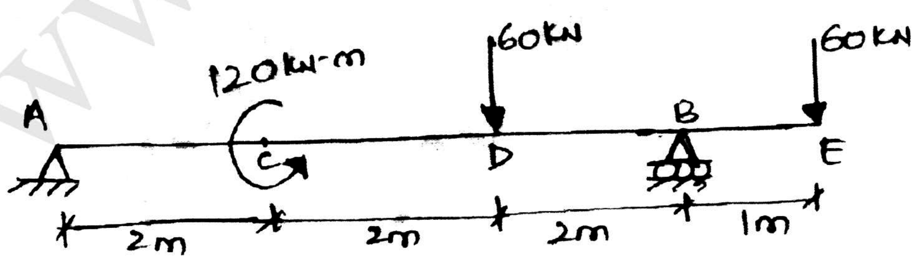
6 a. A simply supported beam is subjected to a UDL of 30 kN/m together with a point load of 30 kN as shown in Fig. Q6 (a). Draw SFD and BMD. Find also point of zero shear and its corresponding BM.



(10 Marks)

Fig. Q6 (a)

b. For the overhanging beam shown in Fig. Q6 (b), plot the SFD and BMD. Locate points of contraflexure if any.



(10 Marks)

Fig. Q6 (b)

Module-4

7 a. State the different theories of failure. Explain any two briefly. **(10 Marks)**

b. Derive the torsion equation with usual notations. **(10 Marks)**

OR

8 a. A solid shaft is to transmit 300 kN-m at 100 rpm. If the shear stress of the material should not exceed 80 MPa, find the diameter required. What percentage saving in weight would be obtained if this shaft is replaced by a hollow one whose $d_i = 0.6d_0$, the length, material and shear stress remaining same. **(10 Marks)**

b. Determine the diameter of a bolt which is subjected to an axial pull of 9 kN together with a transverse shear force of 4.5 kN using,

(i) Maximum principal stress theory

(ii) Maximum principal strain theory.

Given the elastic limit in tension = 225 N/mm^2; Factor of safety = 3

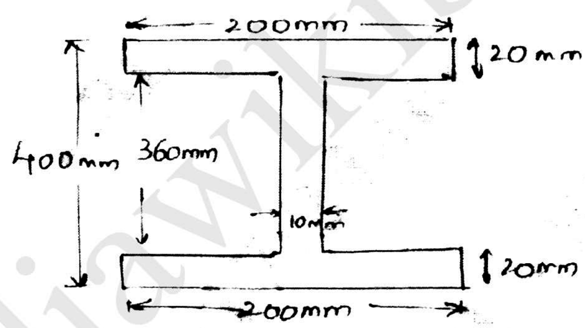
Poisson's ratio = 0.3 **(10 Marks)**

Module-5

9 a. What are the assumptions in bending theory? **(04 Marks)**

b. Derive the equation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ of theory of simple bending with usual notations. **(08 Marks)**

c. A rolled steel joint of I-section has the dimensions as shown in Fig. Q9 (c). This beam of I-section carries a UDL of 40 kN/m run on a span of 10 m. Calculate the maximum stress produced due to bending.



(08 Marks)

Fig. Q9 (c)

OR

10 a. State the assumptions made in Euler's theory. **(04 Marks)**

b. Derive the Euler's equation for buckling load on an elastic column with both ends pinned or hinged. **(08 Marks)**

c. A simply supported beam of length 40 m is subjected to a UDL of 30 kN/m over the whole span and deflects 15 mm at the centre. Determine the crippling loads when this beam is used as a column with the following conditions:

(i) One end fixed and other end hinged.

(ii) Both ends pin jointed.

Take length of beam, ℓ =4000 mm and UDL, $\omega = 30$ kN/m, Deflection at centre = 15 mm. **(08 Marks)**

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Strength of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the four elastic constants. **(06 Marks)**

b. Derive an expression for the displacement of a tapering circular bar subjected to an axial force. **(08 Marks)**

c. The modulus of elasticity and shear modulus of a bar is 200Gpa and 80Gpa respectively. Compute the bulk modulus and reduction in diameter of a circular bar 36mm diameter and 3m long, when stretched by 3mm. **(06 Marks)**

OR

2 a. Write a note on temperature stress in simple bars. **(05 Marks)**

b. Derive the relation between modulus of elasticity, modulus of rigidity and Poisson's ratio. **(08 Marks)**

c. A composite tube consists of a steel tube 165mm internal diameter and 15mm thick enclosed by an aluminium tube 200mm internal diameter and 15mm thick. The composite tube carries an axial load of 1500kN. Compute the stresses in each material, load carried by each material and the compression of the composite tube, if its length is 300mm. E_s = 200Gpa and E_{AL} = 70Gpa. **(07 Marks)**

Module-2

3 a. Explain maximum shear stress theory of failure. **(06 Marks)**

b. A closed cylindrical steel vessel 8m long and 2m internal diameter is subjected to an internal pressure of 5MPa with the thickness of the vessel being 36mm. Compute hoop stress, longitudinal stress, maximum shear stress, change in length, change in diameter and change in volume. Assume E = 200 kN/mm^2 and μ = 0.3. **(08 Marks)**

c. An element is subjected to a tensile stress of $120N/mm^2$ on the vertical plane and another compressive stress of $80N/mm^2$ on the horizontal plane. Compute the normal and tangential stresses on a plane making an angle of 30° anticlockwise with the vertical plane. **(06 Marks)**

OR

4 a. The stresses acting at a point in a two dimensional system is shown in Fig.Q4(a). Determine the principal stresses and planes, maximum shear stress and planes, normal and shear stresses on plane AB. **(10 Marks)**

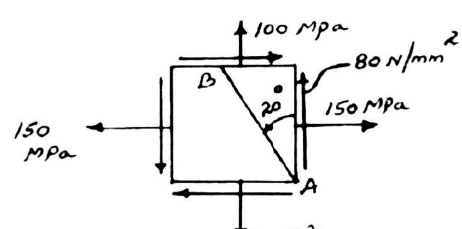


Fig.Q.4(a)

b. Differentiate between thin and thick cylinders. **(03 Marks)**

c. Compute the thickness of the wall of a thick cylinder subjected to an internal pressure of 40 N/mm^2. The internal diameter of the cylinder is 200mm and the permissible hoop stress is 140MPa. Sketch the hoop stress and radial pressure across the thickness assuming zero external pressure. **(07 Marks)**

Module-3

a. Define SF, BM and point of contraflexure. **(03 Marks)**

b. A simply supported beam AB of span L is subjected to a concentrated load at distance 'a' from left support A. Develop expressions for SF and BM. Sketch SFD and BMD. **(05 Marks)**

c. Sketch SFD and BMD for the beam shown in Fig.Q.5(c) indicating the salient points. **(12 Marks)**

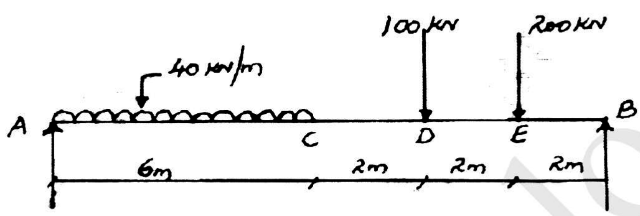


Fig.Q.5(c)

OR

6 a. Sketch SFD and BMD for the beam shown in Fig.Q.6(a) indicating salient points.

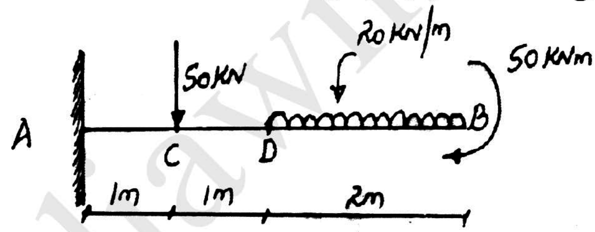


Fig.Q.6(a)

(08 Marks)

b. Sketch SFD and BMD for the beam shown in Fig.Q.6(b) indicating salient points including point of contraflexure. **(12 Marks)**

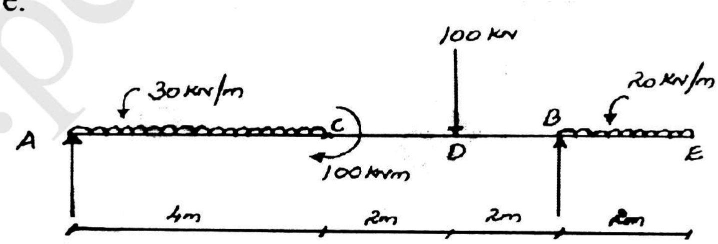


Fig.Q.6(b)

Module-4

7 a. Derive the equation of pure bending $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. A shaft of hollow C/S rotates at 200rpm transmitting a power of 800kW with internal diameter = 0.8 times external diameter. Computer the diameters if the maximum shear stress is limited to 100N/mm^2 and the angle of twist to 1° in a length of 4m. Assume that the maximum torque is 30% greater than the mean torque and G = 80GPa. **(10 Marks)**

OR

8 a. State the assumptions made in the theory of pure torsion. **(05 Marks)**

b. Derive an expression for power transmitted by a shaft. **(05 Marks)**

c. A I-section consists of flanges 200 × 15 with web 10mm thick. Total depth of the section is 500mm. If the beam carries a UDL of 35kN/m over a span of 8m, computer the bending and shear stresses at centre and support respectively. Sketch their distributions. **(10 Marks)**

Module-5

9 a. Derive an expression for slope and deflection in a simply supported subjected to UDL throughout. Calculate the maximum slope and deflection. **(06 Marks)**

b. Define:

i) Buckling load

ii) Effective length

iii) Slenderness ratio. **(06 Marks)**

c. Compute the crippling loads using Euler's and Rankine's formula for a hollow circular column 200mm external diameter and 25mm thick. The length of the column is 4m with both ends hinged. Assume E = 200GPa, Rankine's constants σ_c = 320MPa and a = 1/7500. **(08 Marks)**

OR

10 a. Derive an equation for buckling load in a long column with both ends hinged using Euler's column theory. **(08 Marks)**

b. Determine the slopes at A and B, deflections at C, D and E in the beam shown in Fig.Q.10(b) in terms of EI. **(12 Marks)**

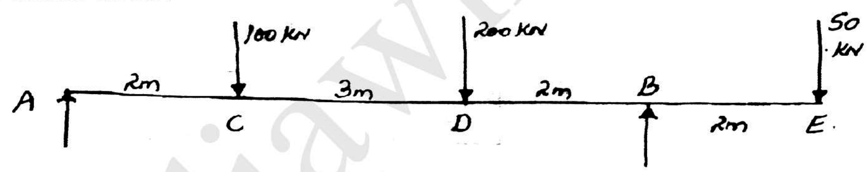


Fig.Q.10(b)

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10CV/EV/CT33

Third Semester B.E. Degree Examination, June/July 2017
Strength of Materials

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Draw the stress-strain diagram for ductile specimen under axial tensile force. Mark the salient points on the diagram and name them. **(06 Marks)**

b. Find the maximum and minimum stresses produced in the stepped bar shown in Fig.Q1(b) due to an axially applied compressive load of 12 kN.

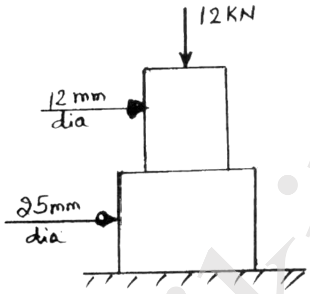

Fig.Q1(b) **(04 Marks)**

c. A 2 mt long steel bar has a uniform diameter of 40 mm for a length of 1 mt from one end. For the next 0.5 mt length the diameter decreases uniformly to "d". For the remaining 0.5 mt length it has a uniform diameter of "d" mm. When a load of 150 kN is applied, the observed extension is 2.40 mm. Determine the diameter "d". Take modulus of elasticity for steel as 200 GPa. [Refer Fig.Q1(c)]

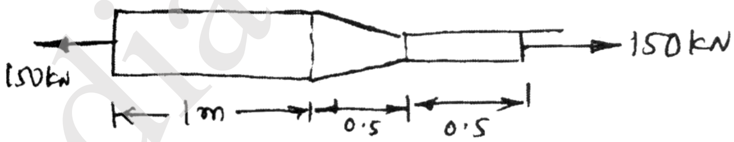

Fig.Q1(c) **(10 Marks)**

2 a. A steel bar is placed between two copper bars each having the same area and length as the steel bar at 15°C. At this stage they are rigidly connected together at both the ends. When the temperature is raised to 315°C, the length of the bars increases by 1.50 mm. Determine the original length and the final stresses in the bars. Take $E_{st} = 2.1 \times 10^5$ N/mm², $E_{cu} = 1 \times 10^5$ N/mm², $\alpha_{st} = 12 \times 10^{-6}$/°C and $\alpha_{cu} = 17 \times 10^{-6}$/°C. **(10 Marks)**

b. A concrete column 300 mm × 300 mm in cross section has 8 bars of 20 mm diameter. The column is subjected to an axial compressive load of 500 kN. Determine the stresses in each material. Also calculate the load shared by the two materials. Take the modular ratio between steel and concrete as 20. **(10 Marks)**

3 a. At a certain point in a strained material the intensities of normal stresses on two planes at right angles to each other are 20 N/mm² and 10 N/mm² both tensile. They are accompanied by shear stress of 10 N/mm². Find the principal planes and principal stresses. Also find the maximum shear stress. **(10 Marks)**

b. The principal stresses at a point in a bar are 200 N/mm² (tensile) and 100 N/mm² (compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 60° to the axis of the major principal stress. Also determine the maximum intensity of shear stress in the material at the point. **(10 Marks)**

4 a. Establish a relationship between bending moment, shear force and loading for a laterally loaded member. **(06 Marks)**

b. Draw shear force and bending moment diagram for the beam loaded as shown in Fig.Q4(b). Also locate the points of contra flexures.

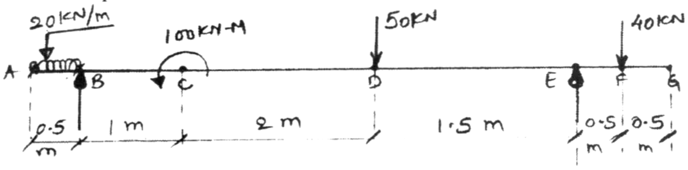

Fig.Q4(b) **(14 Marks)**

PART – B

5 a. For the section shown in Fig.Q5(a), find the (i) Position of the neutral axis, (ii) Section modulus.

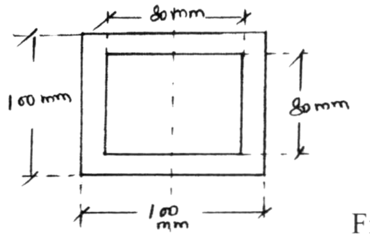

Fig.Q5(a) **(06 Marks)**

b. A steel beam of hollow section of outer side 100 mm and inner side 80 mm is used on a span of 4 mt. Find the uniformly distributed load the beam can carry if the bending stress is not to exceed 120 N/mm^2. The beam is taken as simply supported. [Refer Fig.Q5(a)] **(06 Marks)**

c. The moment of inertia of a beam section 500 mm deep is 69.49×10^7 mm^4. Find the longest span over which a beam of this section, when simply supported, could carry a uniformly distributed load of 50 kN per meter run. The flange stress in the material is not to exceed 110 N/mm^2. **(08 Marks)**

6 a. Establish the relationship between slope, deflection and radius of curvature for a beam. **(06 Marks)**

b. A horizontal girder of steel having uniform section is 14 metres long and is simply supported at its ends. It carries concentrated loads of 120 kN and 80 kN at two points 3m and 4.5m from the two ends respectively. I for the section of the girder is 16×10^8 mm^4 and $E = 210 \times 10^3$ N/mm^2. Calculate the deflections of the girder at points under the two loads. Find also the maximum deflection. **(14 Marks)**

7 a. State the assumptions in the theory of pure torsion. **(05 Marks)**

b. Define: i) Polar section modulus, ii) Torsional rigidity. **(05 Marks)**

c. The external and internal diameters of a hollow shaft are 160 mm and 120 mm respectively. If the shaft is subjected to a torque of 20 kN-m, find:

i) Shear stress at the outer surface of the shaft
ii) Shear stress at the inner surface of the shaft
iii) Angle of hoist per metre length of the shaft.

Take $C = 7.5 \times 10^4$ N/mm^2. **(10 Marks)**

8 a. Derive an expression for the Euler's crippling load for slender column having both ends of the column hinged. **(06 Marks)**

b. Find Euler's critical load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick, if it is 6 meters long and hinged at both ends. Take $E = 8 \times 10^4$ N/mm^2. Compare Euler's critical load with the Rankine's critical load taking $f_c = 550$ N/mm^2 and $a = 1/1600$. For what length of the column would the critical loads by Euler's and Rankine's formula will be equal? **(14 Marks)**

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Third Semester B.E. Degree Examination, Aug./Sept.2020
Strength of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Sketch a typical stress-strain curve for a ductile material and explain briefly the salient features of the curve. **(05 Marks)**

b. Derive an expression for the deformation of a rectangular tapering bar of uniform thickness. **(05 Marks)**

c. Determine the value of P that will not except a maximum deformation of 2mm or a stress of 120 MPa in steel, 80 MPa in Aluminium and 115 MPa in bronze (Fig.Q1(c)). Given the following data:

$A_b = 600\ mm^2$, $E_b = 0.84\times10^5\ N/mm^2$

$A_a = 800\ mm^2$, $E_a = 0.7\times10^5\ N/mm^2$

$A_s = 400\ mm^2$, $E_s = 2.1\times10^5\ N/mm^2$

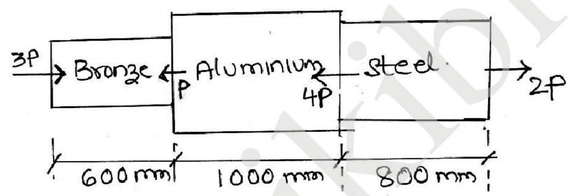

Fig.Q1(c) **(10 Marks)**

OR

2 a. Derive the relationship between Young's modulus and bulk modulus. **(05 Marks)**

b. A load of 270 kN is acting on a RCC column of size 200mm × 200mm. The column is reinforced with 10 bars of 12mm diameter each. Determine the stress in steel and concrete. $E_s = 16.5\ E_c$. **(05 Marks)**

c. A bar of brass 25mm diameter is enclosed in a steel tube of 50mm external diameter and 25mm internal diameter. The bar and tube are both initially 1m long and rigidly fastened at both the ends. Find the stresses in the two materials when the temperature rises from 10°C to 90°C.

If the composite bar is then subjected to an axial tensile load of 60 kN, find the resulting stresses given that : $E_s = 200\times10^3$ MPa, $E_b = 100\times10^3$ MPa, $\alpha_s = 11.6\times10^{-6}/°C$, $\alpha_b = 18.7\times10^{-6}/°C$. **(10 Marks)**

Module-2

3 a. Explain the maximum shear stress theory. **(05 Marks)**

b. Explain the procedure for determining stresses in a general two dimensional stress system using Mohr's circle. **(05 Marks)**

c. At a point in a strained material, the state of stresses is as shown in Fig.Q3(c), Determine the principal stresses, maximum shear stress and sketch the orientation of the principal planes.

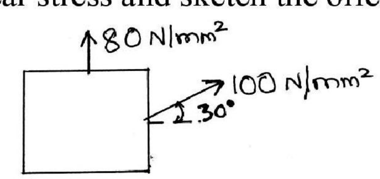

Fig.Q3(c) **(10 Marks)**

OR

4 a. In a thin cylinder, show that he hoop stress is twice the longitudinal stress. **(08 Marks)**

b. The maximum stress permitted in a thick cylinder of internal diameter 100mm and external diameter 150mm is 16 N/mm^2. If the internal pressure is 12 N/mm^2, what external pressure can be applied? Plot curves showing the variation of Hoop stress and radial stress through the material. **(12 Marks)**

Module-3

5 a. Define the terms:
(i) Bending Moment (ii) Point of Inflexion. **(04 Marks)**

b. Draw SFD and BMD for the cantilever beam shown in Fig.Q5(b).

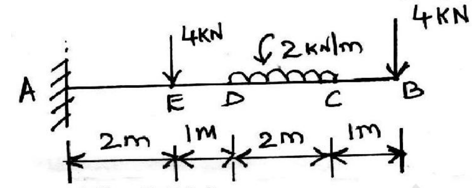

Fig.Q5(b) **(06 Marks)**

c. Draw SFD and BMD for a simply supported beam carrying two point loads of 12 kN at 1/3rd span from either supports in addition to a UDL of 10 kN/m throughout span of beam is 6m. **(10 Marks)**

OR

6 a. Establish the relationship between shear force, bending moment and load intensity. **(06 Marks)**

b. Draw SFD and BMD for the beam shown in Fig.Q6(b). Locate maximum shear force maximum bending moment and point of contraflexure.

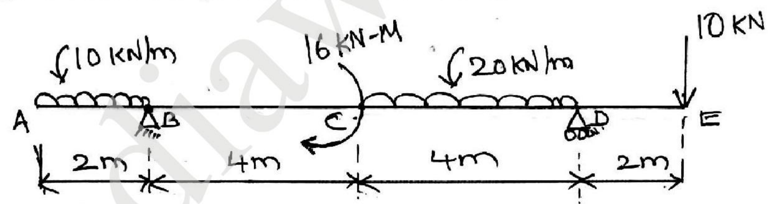

Fig.Q6(b) **(14 Marks)**

Module-4

7 a. Derive the simple bending equation in the form $\frac{M}{I} = \frac{f}{y} = \frac{E}{R}$ with usual notations. **(08 Marks)**

b. A beam of I section consists of 180mm × 15mm flanges and a web of 280mm × 15mm. It is subjected to a bending moment of 120 kN-m and a shear force of 60 kN. Sketch the bending stress distribution and shear stress distribution along the depth of the section. **(12 Marks)**

OR

8 a. Derive the torsion equation for a circular shaft subjected to pure torsion. **(10 Marks)**

b. A solid shaft of 60mm diameter is to be replaced by a hollow shaft of same length. The outer diameter of hollow shaft is same as that of solid shaft. If the angle of twist per unit torsional moment is the same in both cases, determine the inner diameter of hollow shaft. Take the modulus of rigidity of hollow shaft to be three times that of solid shaft. **(10 Marks)**

Module-5

9 a. Derive an expression for the slope and deflection of a simply supported beam carrying a central concentrated load. **(08 Marks)**

b. A simply supported beam of constant cross section is 10m long. It is loaded with two point loads of 100 kN and 80 kN at points 2m and 6m from the left end respectively. Calculate the deflection under each load the maximum deflection. Take E = 200 GPa and I = 18×10^8 mm^4. **(12 Marks)**

OR

10 a. Distinguish between long and short columns. **(04 Marks)**

b. What are the limitations of Euler's column theory? **(04 Marks)**

c. A hollow cast iron column whose outside diameter is 200mm has a thickness of 20mm. It is 4.5m long and fixed at both ends. Calculate (i) Slenderness ratio (ii) Ratio of Euler's and Rankine's critical loads. Take E = 100 GPa, $\alpha = \frac{1}{1600}$ and $\sigma_c = 550$ N/mm^2. **(12 Marks)**

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Strength of Materials

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing one full question from each module.***

Module-1

1 a. Derive an expression for the elongation of a rectangular tapering bar subjected to an axial pull P. **(08 Marks)**

b. A stepped bar is subjected to external loading as shown in Fig. Q1 (b). Determine the magnitude of axial force P such that net deformation in the bar does not exceed 02 mm. E for steel is 200 GPa and that for copper is 100 GPa. Larger diameter and smaller diameters are 40 mm and 15 mm respectively. **(08 Marks)**

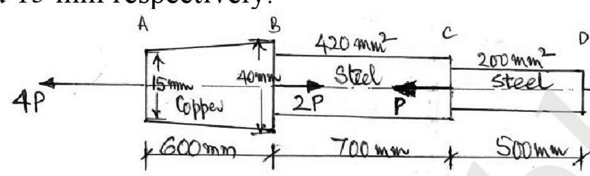

Fig. Q1 (b)

OR

2 a. Derive the relationship between modulus of elasticity (E), modulus of rigidity (C) and bulk modulus (K). **(08 Marks)**

b. Two parallel walls 6 m apart are stayed together by a steel rod 25 mm diameter at a temperature of 80˚C. Calculate the pull exerted by the steel rod when it is cooled to 20˚C if, (i) the walls do not yield (ii) the walls yield together at two ends by 1.5 mm totally. Given: $E = 2\times10^5\ N/mm^2$ coefficient of thermal expansion $= \alpha = 11\times10^{-6}/^\circ C$. **(08 Marks)**

Module-2

3 a. Derive expression for principal stresses and their planes for a two dimensional stress system. **(08 Marks)**

b. The state of stress in a two dimensionally stressed body is as shown in Fig. Q3 (b). Determine the principal planes, principal stresses, maximum shear stress and their planes. Schematically represent these planes on x-y coordinates: **(08 Marks)**

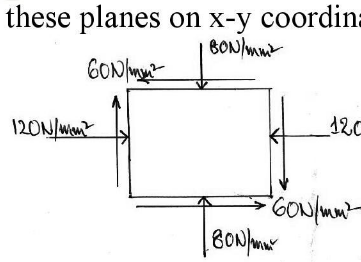

Fig. Q3 (b)

OR

4 a. Show that in the case of a thin cylindrical shell subjected to internal fluid pressure, the volumetric strain is equal to the sum of twice the hoop strain and longitudinal strain and also obtain expression for $e_V = \frac{P.d}{2tE}\left[\frac{5}{2}-\frac{2}{m}\right]$ with usual notations. **(08 Marks)**

b. A thick cylinder of 250 mm internal diameter and 350 mm outer diameter contains a fluid at a pressure of 12 N/mm^2. Determine the hoop stresses and radial stresses and draw a neat sketch showing the stress distribution across wall thickness. **(08 Marks)**

Module-3

5 a. Explain the different types of supports in beams with neat sketches. **(06 Marks)**

b. A overhanging beam with roller and hinged supports is as shown in Fig. Q5 (b). Draw bending moment and shear force diagrams for given loadings. **(10 Marks)**

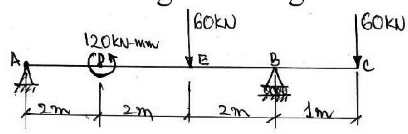

Fig. Q5 (b)

OR

6 a. Derive the relationship between intensity of loading, shear force and bending moment. **(08 Marks)**

b. Draw shear force and bending moment diagrams for a beam loaded as shown in Fig. Q6 (b). Indicate the point of inflexion and locate the points of contraflexure and also maximum bending moment. **(08 Marks)**

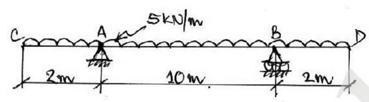

Fig. Q6 (b)

Module-4

7 a. Derive the bending stress equation, $\frac{M}{I} = \frac{f}{y} = \frac{E}{R}$ with usual notations. **(06 Marks)**

b. A beam is of square cross section of sides 100 mm. If the permissible stress is 70 N/mm^2, find the moment of resistance of the beam section. Find whether there is any improvement in moment of resistance if the section is placed with one of the diagonals vertical. **(10 Marks)**

OR

8 a. Write a note on: (i) Effective length of columns (ii) Limitations of Euler's theory on columns. **(08 Marks)**

b. A hollow column of cast iron whose outside diameter is 200 mm has thickness of 20 mm. It is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate slenderness ratio and compare Euler's and Rankine's critical loads.

Take critical stress = σ_C = 550 N/mm^2

Rankine's constant = $\alpha = \frac{1}{1600}$

Elastic modulus = $E = 8 \times 10^4$ N/mm^2 **(08 Marks)**

Module-5

9 a. Derive the expression for torsion in circular shafts and state the assumptions. **(08 Marks)**

b. A solid shaft rotating at 500 rpm transmits 30 kW. Maximum torque is 20% more than mean torque. Allowable shear stress is 65 MPa, modulus of rigidity is 81 GPa and angle of twist in the shaft should not exceed 1° in 1 mt length. Determine the suitable diameter. **(08 Marks)**

OR

10 a. Determine the ratio of power transmitted by a hollow shaft and a solid shaft when both have same weight length, material and speed. The diameter of solid shaft is 150 mm and external diameter of hollow shaft is 250 mm. **(08 Marks)**

b. (i) What is the significance and importance of theories of failure?
(ii) Explain the maximum principal stress theory (Rankine's) **(08 Marks)**

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Strength of Materials

Time: 3 hrs. Max. Marks: 100

Note: *Answer FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Show that volumetric strain is equal to algebraic sum of the strains in three mutually perpendicular directions in case of cuboid. **(05 Marks)**

b. Calculate the diameter of steel rod needed to carry a load of 8 kN, if the extension is not to exceed 0.04 percent. Assume $E = 210\ \text{GN/m}^2$. **(05 Marks)**

c. A reinforced concrete column $300\,\text{mm} \times 300\,\text{mm}$ in size has 4 reinforcement bars of steel 20 mm in diameter. Calculate the safe load, the column can carry if the permissible stress in concrete is 5.2 MN/m², $\frac{E_{\text{steel}}}{E_{\text{concrete}}} = 18$. **(10 Marks)**

OR

2 a. Derive an expression for change in length in case of a uniformly varying circular cross section whose diameter varies from d_1 to d_2 over a length 'L' subjected to an axial force F. **(06 Marks)**

b. A rod is 2 m long at a temperature of 10°C. Find the expansion of the rod when the temperature is raised to 80°C. If this expansion is prevented, find the stress induced in the material of the rod. Take $E = 1.0 \times 10^5\,\text{MPa}$ and $\alpha = 12 \times 10^{-6} /^\circ\text{C}$. **(05 Marks)**

c. A bar of cross section $10\text{mm} \times 10\text{mm}$ is subjected to an axial pull of 8000 N. The lateral dimension of the bar is found to be changed to $9.9985\text{mm} \times 9.9985\text{mm}$. If the modulus of rigidity is $0.8 \times 10^5\ \text{N/mm}^2$, determine the Poisson's ratio and modulus of elasticity. **(09 Marks)**

Module-2

3 a. Derive expressions for hoop stress and longitudinal stress in case of thin cylinder. **(08 Marks)**

b. At a point in a strained material the stresses acting are as shown in Fig. Q3 (b). Determine the (i) Principal stresses and their planes (ii) Maximum shear stress and their planes (iii) Normal and shear stresses on the inclined plane AB. **(12 Marks)**

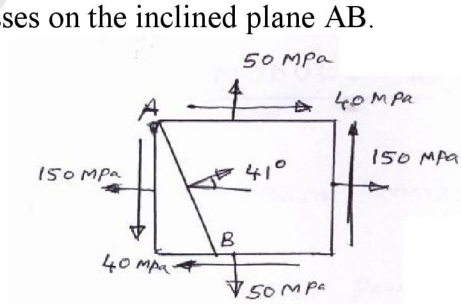

Fig. Q3 (b)

OR

4 a. At a point in a strained material the normal stresses are σ_x and σ_y which are tensile in nature and shear stress acting is τ_{xy}, derive expressions for normal stress and shear stress on an inclined plane making an angle 'θ' with the vertical plane. **(10 Marks)**

b. The inside diameter of thick cylinder is 200 mm. If the internal pressure is 8 N/mm² and maximum permissible stress in cylinder wall is 20 N/mm², what is the minimum thickness required. If the internal pressure is to be increased to 12 N/mm² without exceeding maximum stress, what is the external pressure to be applied? **(10 Marks)**

Module-3

5 a. A cantilever of length 'l' is subjected to a load intensity of w/m at fixed end, uniformly varying to zero at free end. Considering a section 'X' at a distance 'x' from free end, write shear force and bending moment equations and using them draw shear force diagram and bending moment diagram. **(10 Marks)**

b. Draw shear force diagram and bending moment diagram for the Cantilever beam shown in Fig. Q5 (b). **(10 Marks)**

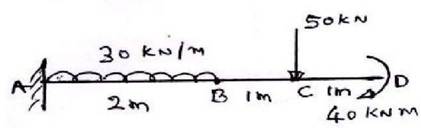

Fig. Q5 (b)

OR

6 a. What is Pare bending? Explain with examples. **(05 Marks)**

b. Draw shear force diagram and bending moment diagram for the beam shown in Fig. Q6 (b). **(15 Marks)**

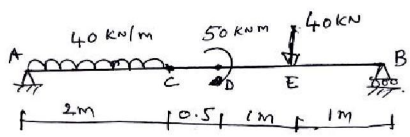

Fig. Q6 (b)

Module-4

7 a. Explain maximum strain energy theory (Beltrami and Haigh). **(05 Marks)**

b. Derive the expression for power transmitted by the shaft. **(05 Marks)**

c. A solid shaft has to transmit 120 kW of power at 160 rpm. If the shear stress is not to exceed 60 MPa and the twist in a length of 3 m must not exceed 1°, find the suitable diameter of the shaft. G = 80 GPa. **(10 Marks)**

OR

8 a. Derive with usual notations the torsion equation,

$$\frac{T}{J} = \frac{\tau_{max}}{R} = \frac{G_\theta}{L}$$

(10 Marks)

b. The cross section of a bolt is required to resist an axial tension of 15 kN and a transverse shear of 15 kN. Estimate the diameter of the bolt by (i) Maximum principal stress theory and (ii) Maximum shear stress theory. The elastic limit of the material is 300 N/mm^2. Poisson's ratio = 0.25 and factor of safety = 3. **(10 Marks)**

Module-5

9 a. Derive Euler's crippling load when both ends of column are hinged. **(06 Marks)**

b. A horizontal beam of the section shown in Fig. Q9 (b) is 4 m long and is simply supported at the ends. Find the maximum uniformly distributed load it can carry if the compressive and tensile stresses are not to exceed 60 MPa and 30 MPa respectively. **(14 Marks)**

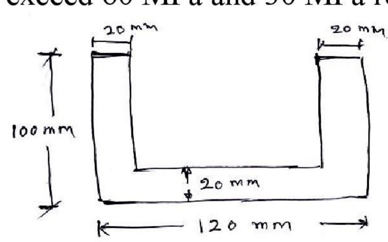

Fig. Q9 (b)

OR

10 a. Define : (i) Neutral axis (ii) Section modulus (iii) Flexural rigidity (iv) Moment of resistance **(08 Marks)**

b. Compare the crippling loads as found from Euler's and Rankine's formula for a mild steel tube of length 3 m, of internal diameter 5 cm and thickness of metal 0.25 cm. Both ends are pin jointed. E = 2.1×10^2 KN/mm^2. Take $\alpha = \frac{1}{7500}$, $\sigma_C = 300$ N/mm^2. **(12 Marks)**