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160ME017

Class test# 1

7½

Q.1 Four wires of same material are subjected to same load. In which of the following case, the elongation will be maximum (length, diameter) [1 mark]

$\Delta L \propto \frac{L}{A} \Rightarrow \frac{L}{A} \uparrow \Delta L \uparrow$

$A = \pi$

(a) 2 m, 1m (b) 4 m, 2m (c) 8 m, 4m (a) 12 m, 6m

Q.2 If $E_s = 3\ E_a$, the stress of a composite bar made of Aluminium and Steel strips each having a cross sectional area of 3000 mm^2 and subjected to an axial load of 12 kN is..... [1 mark]

Q. 3 What is complimentary shear stress? What is its significance? [2 mark]

Q. 4 In case of biaxial stresses [2 mark]

(i) The maximum value of shear stress is ..... $\frac{\sigma_x - \sigma_y}{2}$

(ii) (ii)Each normal stress on two planes of maximum shear stress are..... $\sigma_x \pm \sigma_y$

Q. 5 Two bars, of different materials and of common length1 m, are rigidly joined together. The coefficient of thermal expansion of one material (steel) is 12x 10^{-6} /°c, E= 200 GPa and of second material (Brass) is 18 x 10^{-6} /°c, E= 100 GPa

[2.5 mark]

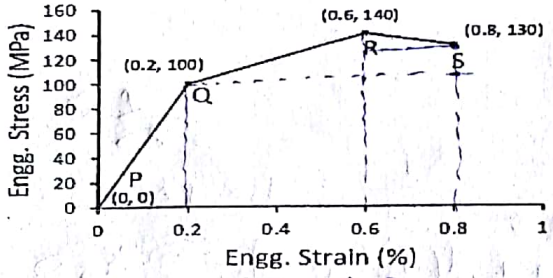
(i) The expanded length of the composite bar for a temperature rise of 10 °c will be..... 3×10^{-4} m

(ii) The stress in the materials will be..24MPa & 18MPa

Q. 6 What do you mean by principal planes and principal stresses? Write the expression for principal stresses for a body subjected to direct and shear stresses. [1.5 mark]

Q. 8 [1.5 mark]

A hypothetical engineering stress-strain curve shown in the figure has three straight lines PQ, QR, RS with coordinates P(0,0), Q(0.2,100), R(0.6,140) and S(0.8,130). 'Q' is the yield point, 'R' is the UTS point and 'S' the fracture point.

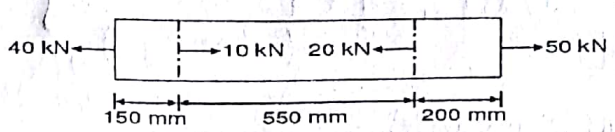


The toughness of the material (in MJ/m^3) is 85 MJ/m^3

Q. 9 What are compound bars? What are equilibrium and compatibility equations? [1.5 mark]

Q.10 Define the term Poisson's ratio. What is its maximum value? [1 Mark]

Q. 12 The loading on a steel bar of 30 mm diameter is as shown in fig.2. Find the elongation of the bar. Take E= 205 GPa [2 mark] 0.18×10^{-3} m



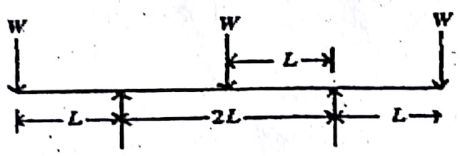
Q.1. $\Delta L \propto \frac{L}{A} \Rightarrow \Delta L \propto \frac{L}{\pi (\frac{d}{2})^2} \Rightarrow \Delta L \propto \frac{L}{d^2}$ (a)

Quiz #2

Each question carries 2 marks.

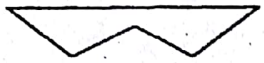
Q. 1 A beam of rectangular section (12 cm wide x 20 cm deep) is simply supported over a span of 12m. It is acted upon by a concentrated load of 80 kN at the midspan. The maximum bending stress induced is.

Q. 2



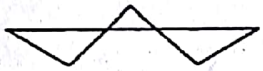
A loaded beam is shown in the above figure. The bending moment diagram of the beam is best represented as

a.



b.

c.



d.

Q. 3

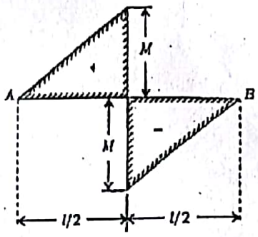


Figure shown above represents the BM diagram for a simply supported beam. The beam is subjected to which one of the following?

a. A concentrated load at its mid-length
b. A uniformly distributed load over its length
c. A couple at its mid-length
d. Couple at 1/4 of the span from each end

Q. 4 What do mean by Beams of uniform strength?

Q.5

A uniformly distributed load w (in kN/m) is acting over the entire length of a 3 m long cantilever beam. If the shear force at the mid-point of cantilever is 6 kN, what is the value of w?

Q. 6

A freely supported beam at its ends carries a central concentrated load, and maximum bending moment is M. If the same load be uniformly distributed over the beam length, then what is the maximum bending moment?

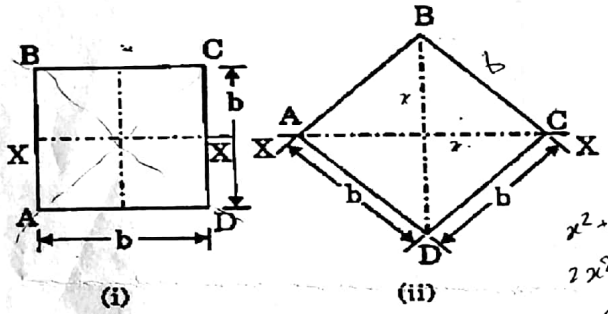
Q. 7 A beam subjected to a bending stress of 5N/mm^2 and the section modulus is 3530 cm^3. What is the moment of resistance of the beam?

Q. 8

For a loaded cantilever beam of uniform cross-section, the bending moment (in N.mm) along the length is $M(x) = 5x^2+10x$, where x is the distance (in mm) measured from the free end of the beam. The magnitude of shear force (in N) in the cross-section at x =10 mm is _____.

Q.9

The ratio of the moments of resistance of a square beam (Z) when square section is placed (i) with two sides horizontal (Z_1) and (ii) with a diagonal horizontal (Z_2) as shown is



$x^2+x^2 = b^2$

$2x^2 = b^2$

$x = \frac{b}{\sqrt{2}}$

Q.10

A beam with a rectangular section of 120 mm x 60 mm, designed to be placed vertically is placed horizontally by mistake. If the maximum stress is to be limited, the reduction in load carrying capacity would be

60×120

Quiz #3

Each question carries 2 marks.

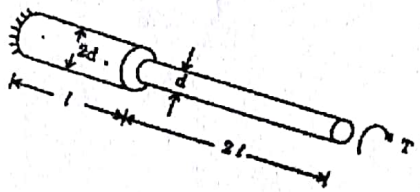
Q.1

If diameter of a long column is reduced by 20%, the percentage reduction in Euler's buckling load for the same end conditions is

Q.2

A solid steel shaft of diameter d and length *l* is subjected to twisting moment T. Another shaft B of brass having same diameter d, but length *l*/2 is also subjected to the same moment. If shear modulus of steel is two times that of brass, the ratio of the angular twist of steel to that of brass shaft is .

Q. 3



What is the total angle of twist of the stepped shaft subject to torque T shown In figure given above?

Q.4

A thin cylindrical shell of diameter d length *l* and thickness t is subjected to an internal pressure p. What is the ratio of longitudinal strain to hoop strain in terms of Poisson's ratio (1/m)?

Q. 5

A cantilever beam of length *l* is subjected to a concentrated load P at a distance of *l*/3 from the free end. What is the deflection of the free end of the beam?

Q. 6

Consider the following statements :

In a cantilever subjected to a concentrated load at the free end

1. The bending stress is maximum at the free end.
2. The maximum shear stress is constant along, the length of the beam.
3. The slope of the elastic curve is zero at the fixed end.

Which of these statements are correct?

a. 1, 2 and 3
b. 2 and 3
c. 1 and 3
d. 1 and 2

Q.7

Four columns of same material and same length are of rectangular cross—section of same breadth b. The depth of the cross—section and the end conditions are, however different are given as follows

Column	*Depth*	*End conditions*
1. 0.6	b	Fixed—Fixed
2. 0.8	b	Fixed—hinged
3. 1.0	b	Hinged—Hinged
4. 2.6	b	Fixed—Free

Which of the above columns has the maximum value of Euler buckling load?

Q. 8 A thin walled spherical shell is subjected to an internal pressure. If the radius of the shell is increased by 1% and the thickness is reduced by 1%, with the internal pressure remaining the same, the percentage change in the circumferential (hoop) stress is

Q. 9 A cantilever beam of length L is subjected to a moment M at the free end. The moment of inertia of the beam cross section about the neutral axis is I and the Young's modulus is E. The magnitude of the maximum deflection is

Q. 10

If the area of cross-section of a circular section beam is made four times, keeping the loads, length, support conditions and material of the beam unchanged, then the qualities (List I) will change through different factors (List II). Match the List I with the List II and select the correct answer using the code given below the Lists:

List I

A. Maximum BM

B. Deflection

C. Bending Stress

D. Section Modulus

List II

1. 8
2. 1
3. 1/8
4. 1/16

	A	B	C	D
a.	3	1	2	4
b.	2	4	3	1
c.	3	4	2	1
d.	2	1	3	4

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The LNM Institute of Information Technology
Department of Mechanical and Mechatronics Engineering
Mechanics of Solids
Mid Term Exam

Time: 1.5 Hrs **Date:** 26/09/2017 **Max. Marks:** 50

Note: Question no. 1-10 carry 2.5 marks each.Proper explaination is required to get full marks

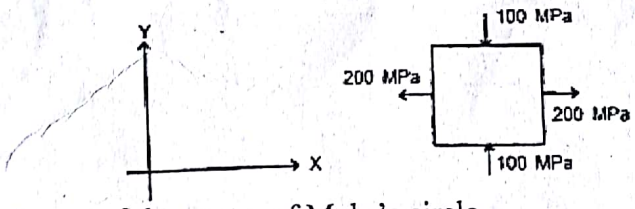
Q.1 A bar produces a lateral strain of magnitude 60×10^{-5} *mm* when subjected to a tensile stress of magnitude 300 MPa along the axial direction. the elastic modulus of the material..... if the Poisson's ratio is 0.3

Q.2 Plane stress at a point in a body is defined by principal stresses 3σ and σ. The ration of the normal stress to the maximum shear stress of the plane of maximum shear stress is.....

Q.3 Draw the Mohr's circles for the state of pure shear and for the state of uniaxial loading.

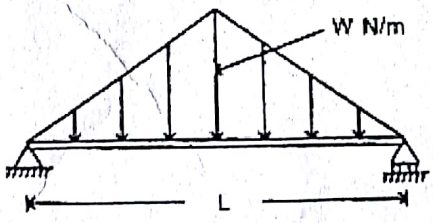
Q. 4 A rod of material with $E = 200 \times 10^3$ MPa and $\alpha = 10^{-3}$ mm/mm°C is fixed at both the ends. It is uniformly heated such that the increase in temperature is 30°C. The stress developed in the rod will be.....

Q. 5 Consider a two dimensional state of stress given for an element as shown in the diagram given below



Write the coordinates of the centre of Mohr's circle.

Q. 6 A simply supported beam is subjected to a distributed loading as shown in the diagram given below

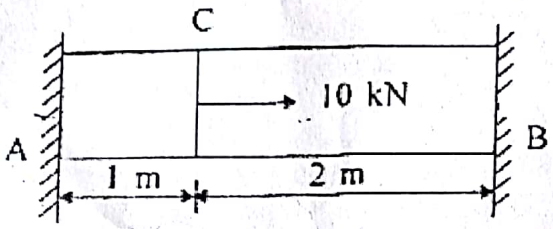


What is the maximum shear force in the beam?

Q. 7 In a strained material one of the principal stresses is twice the other. The maximum shear stress in the same case is q_{max}. Then, what is the value of the maximum principle stress will be.....

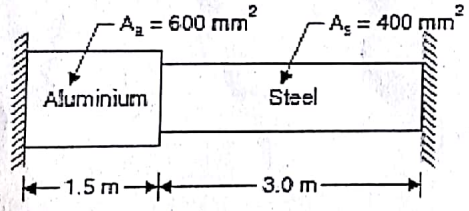
Q. 8 A cantilever beam of 2 m length supports a triangularly distributed load over its entire length, the maximum of which is at the free end. The total load is 37.5 kN. What is the bending moment at the fixed end?

Q. 9 A Prismatic bar, as shown in figure is supported between rigid supports. Determine the support reactions.

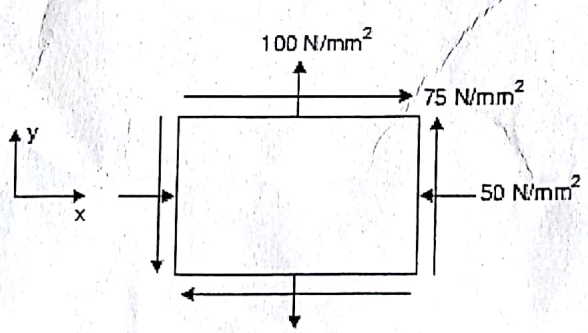


Q. 10 In a Mohr's circle, write the expression for radius of the circle if σx and σy, are normal stresses along x and y directions respectively, and q_{xy} is the shear stress.

Q. 11 The composite bar shown in Fig. is rigidly fixed at the ends A and B. Determine the reaction developed at ends when the temperature is raised by 18°C. Given Ea = 70 kN/mm^2, Es = 200 kN/mm^2, $\alpha_a = 11 \times 10^{-6}$/°C, $\alpha_s = 12 \times 10^{-6}$/°C [5 Marks]



Q. 12 State of stress at a point in a material is as shown in the Fig.(a). Determine (i) principal stresses (ii) maximum shear stress (iii) plane of maximum shear stress and (iv) the resultant stress on the plane of maximum shear stress. [10 Marks]



Q. 13 A simply supported beam of 9 m length carries a point load of 10 kN at the right end and a uniformly distributed load of 30 kN/m for a distance of 3 m starting from left end. The supports of the beams are 6 m apart, the left end support being at the left end. Draw the shear force and bending moment diagrams and also locate the point of contra flexure. [10 Marks]

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Department of Mechanical and Mechatronics Engineering

Mechanics of Solids

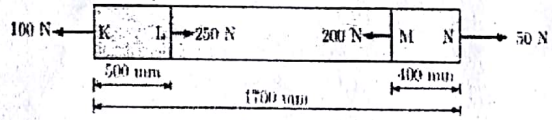
End Term Exam

Time: 3 Hrs **Date:** 30/11/2017 **Max. Marks:** 100

Q.1 Short- Answer Questions [14 X 2.5= 35]

(i) A simply supported beam of length L is subjected to a varying distributed load sin ($3\pi x / L$) N/m where the distance x is measured from the left support. The magnitude of the vertical reaction force in N at the left support is

(ii) A steel rod as shown rod of 25mm^2 cross sectional area. It is loaded at four points, K, L, M and N. Assume, Esteel = 200GPa. The total change in length of the rod due to loading is



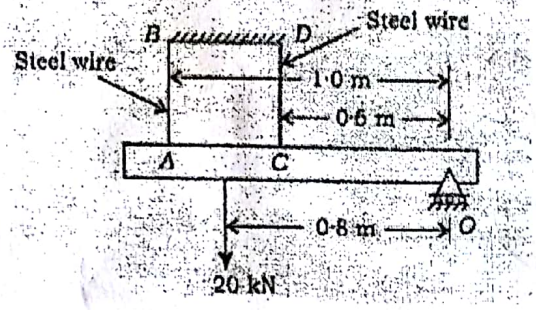
(iii) A simply supported beam of span length 6 m and 75 mm diameter carries a uniformly distributed load of 1.5 kN/m. What is the maximum value of bending stress?

(iv) The state of stress at a point "P" in a two dimensional loading is such that the Mohr's circle is a point located at 175 MPa on the positive normal stress axis.The maximum and minimum principal stresses respectively from the Mohr's circle are

(v) A steel rod, 20 mm diameter and 1.5 m long, free to expand is heated from 25°C to 40 °C. Determine the stress in the rod if E = 200 × 10^3 MPa and $\alpha = 12 \times 10^{-3}$/°C

(vi) What is meant by equivalent length of columns? What are its values for different end conditions of columns?

(vii) A rigid bar *ACO* as shown is hinged at *O* and is held in a horizontal position by two identical vertical steel wires *AB* and *CD*. A point load of 20 kN is hung at the position shown. The tensions in wires *AB* and *CD* are



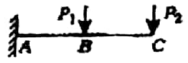
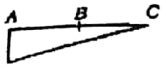
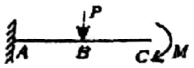
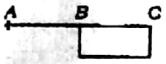
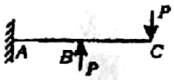
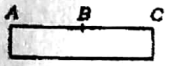
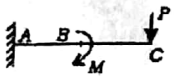
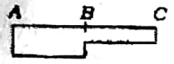
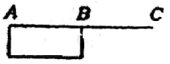
(viii) A steel specimen 150 mm2 in cross secion stretches by 0.05 mm over a 50 mm gauge length under an axial load of 30 kN. What is the strain energy stored in the specimen, Take E = 200 GPa.

(ix) A steel wire of 8 mm diameter is used to lift a weight of 1.5 kN at its lower end. The density of wire material is 8000kg/m^3. Determine the elongation of the wire if the length of the wire is 100m. Take E = 205 GPa.

(x) Determine the ratio of strength of a hollow shaft to that of a solid shaft subjected to torsion if both are of same material and of the same outer diameters, the inner diameter of hollow shaft being half of the outer diameter.

(xi)

Match List-I with List-II

List-I (Cantilever Loading)	*List-II (Shear Force Diagram)*
A. 	1. 
B. 	2. 
C. 	3. 
D. 	4. 
	5. 

(xii) A uniform bar, simply supported at the ends, carries a concentrated load P at mid span. If the same load be, alternatively uniformlydistributed over the full length of the bar, the maximum deflection of the bar decrease by what amount ?

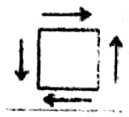
(xiii)

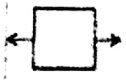
A thin cylinder contains fluid at a pressure of 500 N/m^2, the internal diameter of the shell is 0.6 m and the tensile stress in the material is to be limited to 9000 N/m^2. The shell must have a minimum wall thickness of nearly

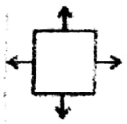
(xiv)

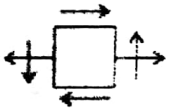
Match List - I with List - II and select the correct answer using the code. given below the Lists :

List - I (State of Stress)

A. 

B. 

C. 

D. 

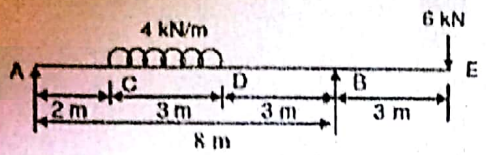
List - II (Kind of Loading)

1. **Combined bending and torsion of circular shaft**
2. **Torsion of circular shaft**
3. **Thin cylinder subjected to internal pressure**
4. **Tie bar subjected to tensile force**

Q. 2 (a) A simply supported cast iron square beam of 800 mm length and 15mm x 15mm in section fails on applying a load of 360 N at the mid span. Find the maximum uniformly distributed load that can be applied safely to a 40 mm wide, 75 mm deep and 1.6 m long cantilever beam made of the same material. [8 marks]

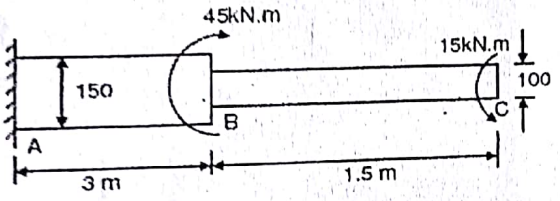
(b) Prove that the ratio of maximum to average shear stress in a rectangular section is 1.5. [6 marks]

Q. 3 Determine deflection of the free end and the maximum deflection between the supports A and B of overhanging beam ABC as shown, Take E= 200 GPa and I= 15 x 10^6 mm^4 [12 marks]



Q. 4 (a) Two shafts of the same material, transmitting the same power. The first shaft rotates at 50 rpm while the second at 5000 rpm. Determine the ratio of diameters of the two shafts for the same maximum shear stress in each shaft. [6 marks]

(b) A steel shaft ABC as shown is of 150 mm diameter over a length of AB = 3 m and of 100 mm diameter over a length of BC = 1.5 m. At B, a clockwise torque of 45 kN-m and at C a counter-clockwise torque of 15 kN-m is applied. If the shaft is in equilibrium, determine, determine (i) the maximum shear stress in the shaft, (ii) angle of twist of B with respect to A, and (iii) angle of twist of C with respect to A. Take G = 80 GPa [8 marks]



Q. 5 (a) A 5m long simply supported beam is applied a uniformly distributed load of 40 kN/m over the entire span. The deflection at the mid-span is observed to be 15 mm. find the crippling load when this beam is used as a column with one end fixed and the other hinged. [5 marks]

(b) Develop the scant formula for column with eccentric loading. [5 marks]

(c) Show that the volumetric strain of a cylindrical shell is the sum of longitudinal strain and twice of hoop strain. [5 marks]