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The LNM Institute of Information Technology
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

100 N ← K   L ← 250 N   200 N → M   N → 50 N
500 mm   400 mm
1700 mm
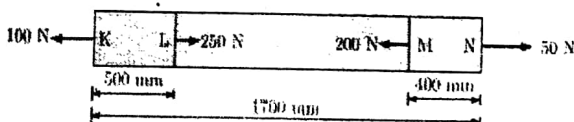
(iii) A simply supported beam of span length 6 m and 75 mm diameter carries a uniformly distributed load of 1.5 kN/m. What is the maximum value of bending stress?

(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 α = 12 x 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
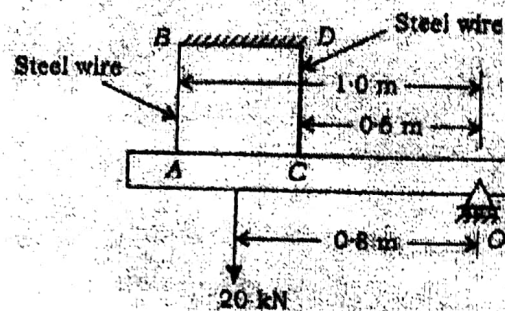

(viii) A steel specimen 150 mm2 in cross secion stretches by 0.05 mm over a 50 mm gauge length under an axial load of 30 kN. What is the strain energy stored in the specimen, Take E = 200 GPa.

(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.

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(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.
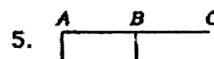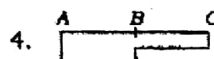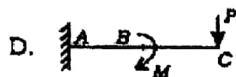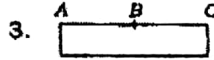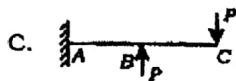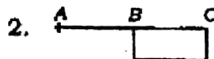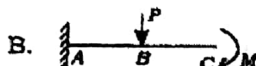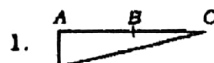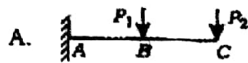
(xii) A uniform bar, simply supported at the ends, carries a concentrated load P at mid span. If the same load be, alternatively uniformlydistributed over the full length of the bar, the maximum deflection of the bar decrease by what amount ?
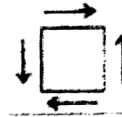
(xiii) A thin cylinder contains fluid at a pressure of 500 N/m², the internal diameter of the shell is 0.6 m and the tensile stress in the material is to be limited to 9000 N/m². The shell must have a minimum wall thickness of nearly

(xiv) Match List - I with List - II and select the correct answer using the code. given below the Lists :
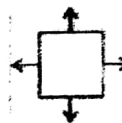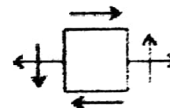
List - I (State of Stress)

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 10⁶ mm⁴ [12 marks]
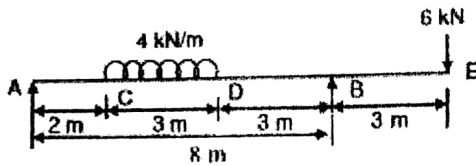
Q. 4 (a) Two shafts of the same material, transmitting the same power. The first shaft rotates at 50 rpm while the second at 5000 rpm. Determine the ratio of diameters of the two shafts for the same maximum shear stress in each shaft.   [6 marks]

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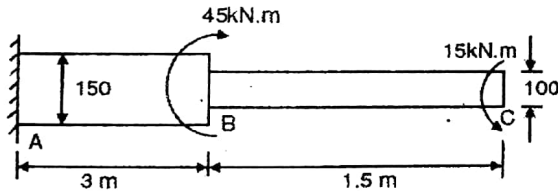
Q. 5 (a) A 5m long simply supported beam is applied a uniformly distributed load of 40 kN/m over the entire span. The deflection at the mid-span is observed to be 15 mm. find the crippling load when this beam is used as a column with one end fixed and the other hinged.   [5 marks]

(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]

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