Sub Code:NME302

Paper Id: Roll No:

B. TECH
(SEM-III) THEORY EXAMINATION 2019-20
MECHANICS OF SOLIDS

Time: 3 Hours *Total Marks: 100*

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x10 = 20

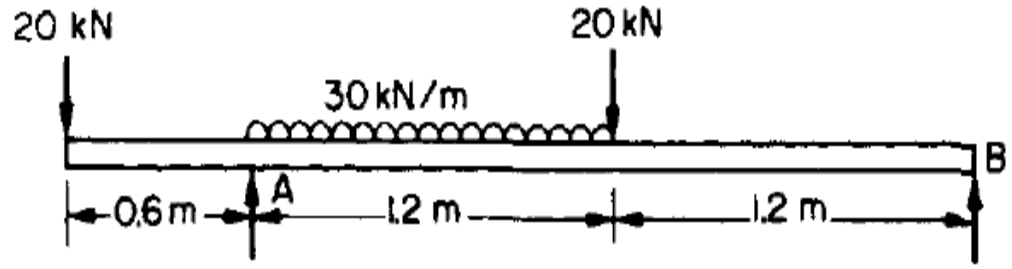
a. Define section modulus in case of a beam subjected to bending.
b. Differentiate between bending of straight and curved beam.
c. What do you understand by theories of failures? Explain any one theory in brief.
d. Explain circumferential and longitudinal stresses in thin cylindrical shell subjected to internal pressure.
e. Define shear centre and its importance.
f. What do understand by torsional rigidity and angle of twist?
g. What do you understand by hydrostatic stress? Give one example of it.
h. Explain Castigliano's theorem and its importance.
i. Explain Hooke's law and differentiate between Young's modulus and modulus of rigidity.
j. What do you mean by Buckling Load in case of column?

SECTION B

2. Attempt any *three* of the following: 10 x 3 = 30

a. An I-section girder, **200** mm wide by **300** mm deep, with flange and web of thickness **20** mm is used as a simply supported beam over a span of **7** m. The girder carries a distributed load of 5 kN/m and **a** concentrated load of **20** kN at mid-span. Determine: (a) the second moment of area of the cross-section of the girder, (b) the maximum stress set-up.

b. Determine the deflection at a point 1 m from the left end of the beam loaded as shown in figure using Macaulay's method. EI = 0.65 MNm^2.



c. A 75 mm x 75 mm x 12 mm angle is used as a cantilever with the face AB horizontal as shown in figure. A vertical load of 3 KN is applied at the tip of the cantilever which is 1 m long. Determine the stresses at A, B and C.

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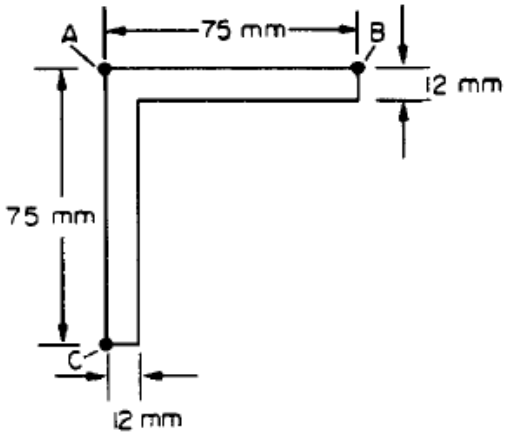
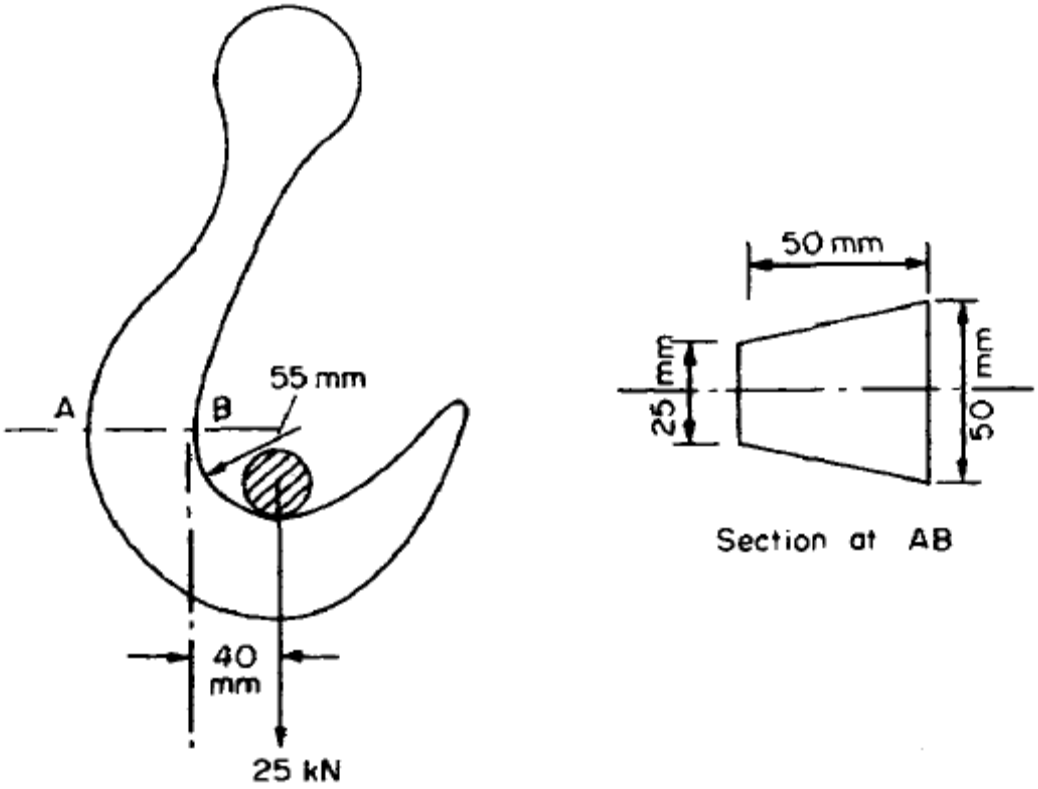


d. A crane hook is constructed from trapezoidal cross-section material. At the critical section ***AB*** **the** dimensions **are** as shown in Fig. **.** The hook supports a vertical load of **25 kN** with a line of action **40** mm from ***B*** on the inside face. Calculate the values of the stresses at points ***A*** and ***B*** taking into account **both** bending and direct load effects **across** the section.



e. Calculate Euler's buckling load for a strut having T-section. The strut is 3 m long and hinged at both ends.The T-section has the following dimensions:
Flange ------ 10 cm x 1 cm
Web ------- 7 cm x 1 cm
Take E = 2.1 x 10^4 KN/cm^2

SECTION C

3. Attempt any *one* part of the following: 10 x 1 = 10

(a) Prove that the maximum shear stress is 3/2 times of the average shear stress in beam of rectangular section subjected to a shear force.

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(b) A short column is of hollow circular section, the center of the inside hole being 6 mm eccentric to that of the outside. The outside diameter is 100 mm and the inside 50 mm .The line of action of the load intersects the cross-section at a point in line with the two centers .What are the limiting position of the load for there to be no tensile stress set up?

4. Attempt any *one* part of the following: 10 x 1 = 10

(a) In a certain material under load a plane AB carries a tensile direct stress of **30** MN/m^2 and a shear stress of 20 MN/m^2, while another plane **BC** carries a tensile direct stress of 20 MN/m^2 and a shear stress. If the planes are inclined to one another at 30^0 and plane **AC** at right angles to plane **AB** carries a direct stress unknown in magnitude and nature, find:
(a) the value of the shear stress on **BC;**
(b) the magnitude and nature of the direct stress on AC;
(c) the principal stresses

(b) A steel tube of 24 mm external diameter and 18 mm internal diameter encloses a copper rod 15 mm diameter to which it is rigidly attached at each end. If, at a temperature of 10^0C there is no longitudinal stress, calculate the stresses in the tube and rod when the temperature is raised to 200^0C.

$E_{steel} = 210$ kN/mm^2 $E_{copper} = 210$ kN/mm^2

Coefficients of linear expansion:
$\alpha_{steel} = 11 \times 10^{-6}$ /^{0}C $\alpha_{copper} = 11 \times 10^{-6}$ /^{0}C

5. Attempt any *one* part of the following: 10 x 1 = 10

(a) Derive a relation to determine buckling load for a column whose both ends are hinged. Also, mention the assumptions made while deriving the relation.

(b) The span of simply supported and centrally loaded laminated steel spring is 650 mm. The central deflection of the spring does not exceed 40 mm for a proof load of 6 kN. The bending stress also does not exceed 360 MPa. Find the suitable values of width, thickness and the number of plates if they are available in multiples of 1mm for thickness and 5 mm for width. Also determine the radius to which the plates should be formed. Assume the width to be ten times the thickness E= 205 GPa.

6. Attempt any *one* part of the following: 10 x 1 = 10

(a) An open coiled helical spring has 12 turns wound to a mean diameter of 100 mm. The angle of the coils with a plane perpendicular to the axis of the coil is 30 degree. The wire diameter is 8 mm. Determine (a) The axial extension with a load of 80 N (b) The angle turned by the free end if free to rotate. E = 205 MPa and G = 80 GPa.

(b) A thick steel cylinder has inner and outer diameters as 120 mm and 180 mm respectively. It is subjected to an external pressure of 9 MPa. Find the value of the internal pressure which can be applied if the maximum stress is not to exceed 30 MPa. Draw the curves showing the variation of hoop and radial stresses through the material of the cylinder.

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7. Attempt any *two* parts of the following: 5 x 2 = 10

(a) A wagon weighing 35 kN moves at a speed of 3.6 km/h. Find the number of springs required in a buffer stop to absorb the energy of motion during a compression of 180 mm. The mean diameter of coils is 220 mm and the diameter of the steel rod of the spring is 24 mm. Each spring consists of 30 coils. G = 90 GPa.

(b) Using moment area method, determine the deflection and slope at the free end of a cantilever carrying a concentrated load P at a distance 'a' from free end.

(c) A steel rod 20 mm in diameter passes centrally through a steel tube of 25 mm internal diameter and 30 mm external diameter. The tube is 800 mm long and is closed by rigid washers of negligible thickness which are fastened by nuts threaded on the rod. The nuts are tightened until the compressive load on the tube is 20 kN. Calculate the stresses in the tube and the rod.

Find the increase in these stresses when one nut is tightened by one-quarter of a turn relative to the other. There are 4 threads per 10 mm. Take E = 2 X 105 N/mm2.