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Total No. of Questions : 09]

[Total No. of Pages : 03

B.Tech. (Sem. – 3rd)

STRENGTH OF MATERIALS - I

SUBJECT CODE : ME - 201

Paper ID : [A0801]

[Note : Please fill subject code and paper ID on OMR]

Time : 03 Hours **Maximum Marks : 60**

Instruction to Candidates:

1) Section - A is **Compulsory**.
2) Attempt any **Four** questions from Section - B.
3) Attempt any **Two** questions from Section - C.

Section - A

Q1) *(10 × 2 = 20)*

a) An axial force of 100kN is applied to a uniform tension bar with cross-sectional area A of 350cm^2. Compute the normal and shear stress on a plane whose normal makes an angle of 30° with the axis of the member.

b) Plot the stress-strain curve for ductile materials indicating salient points on the curve.

c) What shall be axial stress in a bar fixed between two walls, if the temperature of the bar is uniformly increased by 30°C. The length of the bar is 300mm and bar has an outer diameter of 20mm and inner diameter of 15mm. Take E = 200GPa and coefficient of thermal expansion as 11.7×10^{-6}/°C.

d) What shall be the area of the bending moment diagram of a simply supported beam of length L loaded with a concentrated load P at the middle?

e) What is the ratio of polar second moment of area for a solid rod of diameter 20mm to that of a hollow rod of internal diameter 15mm and thickness 2.5mm?

f) Find the slenderness ratio of a 3m long circular column fixed at both ends. The diameter of the column is 300mm.

g) What will happen to the angle of twist of a circular shaft, subjected to a twisting moment T, if a solid shaft of diameter d is replaced by a hollow shaft of outer diameter d and inner diameter $0.4d$, all other parameters remaining the same?

h) A simply supported beam of span 5m carries a 'udl' of intensity '10kN/m' throughout its span. If the width '100mm' of the beam is constant throughout the span, what will be the beam's depth at the mid-span if the permissible bending stress is '*30MPa*'?

i) Briefly explain the distortion energy theory of failure.

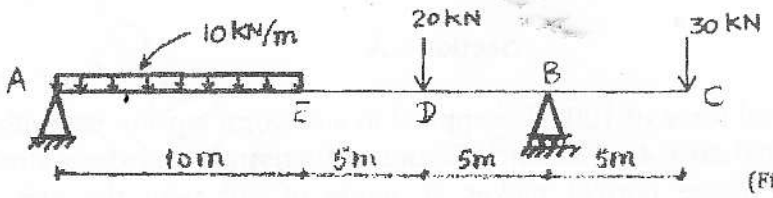
j) Briefly explain the concept of the point of contra-flexure.

Section - B

(4 × 5 = 20)

Q2) The cross-section of a bar is given by $(1 + x^2 / 100)$ cm^2 where x cm is the distance from one end. Find the extension under an axial load of 20kN on a length of 10cm. Take E = 200GPa. Also find the axial stress in the middle of the bar.

Q3) A beam 25m long is supported and loaded as shown in the Fig.1. Sketch the shear force and bending moment diagrams and also find the point of contraflexure.



(Fig.1)

Q4) A solid alloy shaft 5cm diameter is to be coupled in series with a hollow steel shaft of same external diameter. Find the internal diameter of the steel shaft if the angle of twist per unit length is 75% of that of the alloy shaft. Determine the speed at which the shafts are to be driven to transmit 200kW, if the limits of shearing stresses are to be 55MPa and 75MPa in alloy and steel respectively. $G_{STEEL} = 2.2\ G_{ALLOY}$.

Q5) Compare the crippling loads given by Euler's and Rankine's formulae for a tubular strut 2.3m long having outer and inner diameters of 38mm and 33mm, respectively, loaded through pin joints at both ends. Take the yield stress as 320MPa and the Rankine's constant as 1/7500. E = 200GPa. For what length of the strut does the Euler's formula cease to apply?

Q6) A thin cylindrical shell, 1.5m internal diameter, 2.4m long, internal volume 4.23m^3, plates 25mm, thick is under internal pressure of 1N/mm^2. Assuming that the end plates are rigid, find the changes in length, diameter and volume. Take E = 2.06×10^5 N/mm^2 and Poisson's ratio = 0.267.

Section - C

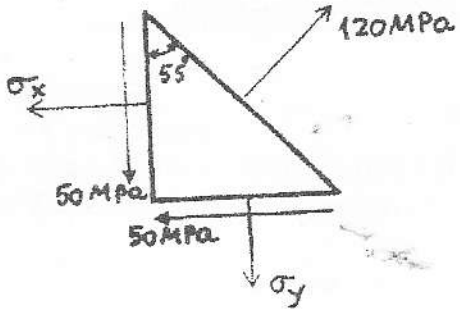
(2 × 10 = 20)

Q7) A plane at a point in a strained material subjected to two-dimensional stress system transmits a shear stress of 50MPa along with an unknown tensile stress. The maximum principal stress in the material is 120MPa (tension) acting on the plane inclined at 55° with the plane under consideration as shown in Fig.2.

(a) Determine analytically the second principal stress and
(b) Construct the Mohr's circle diagram.

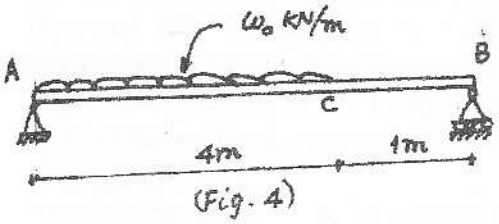
Also calculate the strain normal to the plane.

The elastic modulus and the Poisson's ratio of the material are 200GPa and 0.3, respectively.

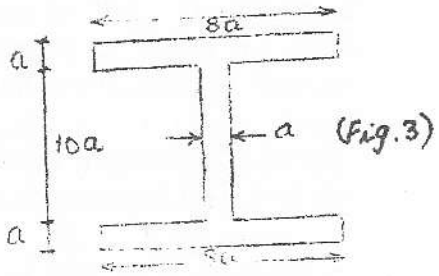


(Fig.2)

Q8) A simply supported I-beam of length 5m having the cross-section as shown in Fig.3 with a = 25mm, carries a uniformly distributed load of intensity w_0kN/m over a length of 4m from the left support as shown in Fig.4. Determine the maximum value of w_0 at which the shearing stress and the flexural stress will not exceed their allowable values of 1.0MPa and 10MPa, respectively.



(Fig. 4)



(Fig.3)

Q9) A horizontal cantilever 2m long has its free end attached to a vertical tie rod 3m long and 300mm^2 area. initially unstrained. Determine the load taken up by the tie rod and the deflection of cantilever at the middle when a distributed load of 30kN/m is applied to the outer 1m of the beam.

Take I = 6×10^6mm^4 and E = 205GPa for both the beam and the rod.