B.Tech Even Semester Examination, May, 2025

Agricultural Engineering
(4th Semester)

Course No: AGPC-252/AE-401
(Strength of Materials)

Full Marks: 70
Pass Marks: 28
Time: 3 hours

Note:
1. Attempt any five questions taking one from each unit.
2. Begin each answer in a new page
3. Answer parts of a question at a place
4. Assume reasonable data wherever required
5. The figure in the right margin indicates full marks for the question
6. All the mathematical symbols and abbreviations have their usual meanings.

UNIT-I

1. (a) Define the followings

i) Hooke's Law with equation

ii) Poisson's ratio

iii) Factor of safety

iv) Strain Energy [6]

(b) A bar of rectangular section is subjected to stresses P_x, P_y and P_z in x, y and z directions respectively. Show that if sum of these stresses is zero, there is no change in the volume of the bar. [4]

(c) A bar of 30mm diameter is subjected to a pull of 60 KN. The measured extension on gauge length of 200 mm is 0.1mm and change in diameter is 0.004 mm, calculate: (i) Young's modulus (ii) Poisson's Ratio and (iii) bulk modulus. [2+1+1]

2. (a) For the state of stress at a point in a strained material is given as follows:

σ_x=400 MPaσ_y=-300 MPaσ_{xy}=200 MPa CW

(a) Draw the initial stress element.

(b) Draw the complete Mohr's circle, labeling critical points.

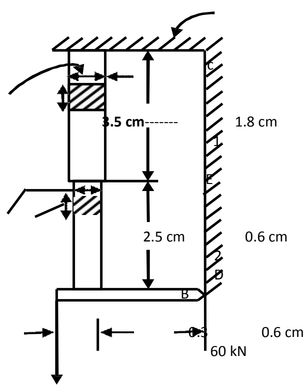
(c) Draw the complete principal stress element.

(d) Draw the maximum shear stress element. [7]

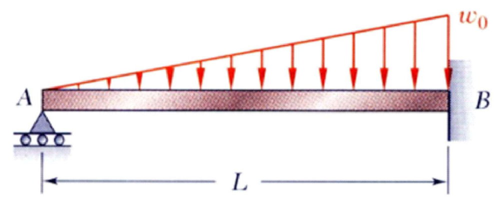
(b) Abeam AB hingedat A is loadedat Bas shown in Fig. 1. It is supported from the roof by a 2.4 cm long vertical steel bar CD which is 3.5 cm square for the first 1.8 mlength and 2.5 cm square for the remaining length. Before the load is applied, the be amhangs horizontally. Take E_s = 210 GPa Determine:

i. The maximum stress in the steel bar CD:

ii. The total elongation of the bar. [5]



statically indeterminate to the first degree) [5+6+3]



10. (a) Derive and explain where it is used and why:

1. Limitations Of Eulers Theory

2. Rankine formula [3.5+3.5]

(b) A steel column of circular cross-section with a length of 2.5 m is fixed at one end and free at the other.

The column is designed to carry an axial compressive load.

Given:

- Young's modulus E=200 GPa
- Critical buckling load P_{cr}=20 kN
- Factor of safety = 2.5

Assume Euler's formula is applicable.Determine:

1. The minimum required diameter of the column.

2.If the diameter chosen is 5 cm, calculate the actual critical load and comment on safety. 7

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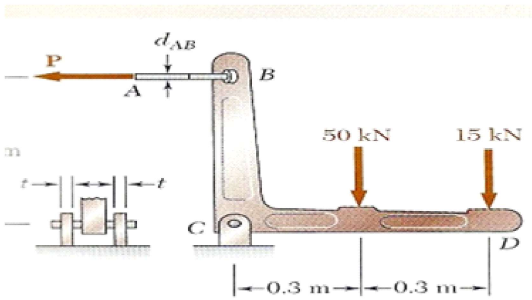

Fig.7

8. For the line shaft running at 200 rpm and 5 cm diameter throughout its length as shown in Fig.7, a torque of 200 Nm is applied at B. Torques taken off from the shaft to various machines from section A, C and d are 100 Nm, 20 Nm and 80 Nm respectively. Show variation of torque, surface shear stress and relative angle of twist along the length of the shaft. What is the maximum shear stress and the angle of twist between the ends of the shaft? Take G= 80 x 10^9 N/m^2. Assume the shaft is sufficiently supported on a number of bearings so that bending may be neglected. [7+3+4]

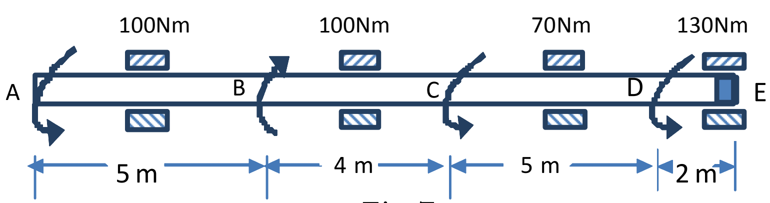

Fig.7

UNIT-V

9. For the uniform beam, determine the reaction at A, derive the equation for the elastic curve, and determine the slope at A. (Note that the beam is

(c) Draw the Stress-StrainDiagram and denote the yield point, Elastic limit, Proportional Limit, Ultimate Strength, Actual rupture strength, and Rupture Strength. [2]

UNIT-III

3. (a) Determine the co-ordinates X_c and Y_c of the centre of a 10 mm diameter circular cut a thin plate so that this point will be the centroid of the remaining shaded area shown in Fig. 1. [5]

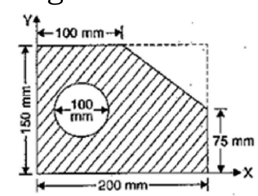

Fig. 1

(b) Fig. 2 shows a T-section of dimensions10 x 10 x 2 cm. Determine the moment of inertia of the sectionabout the horizontal and vertical axes, passing through the centre of gravity of the section. Also find the polar moment of inertiaof the given T-section. [5]

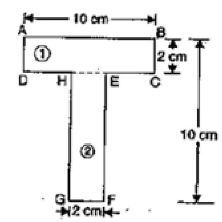

Fig. 2

(C) Determine the moment of inertia of the uniform thin rod shown in fig. 3. [4]

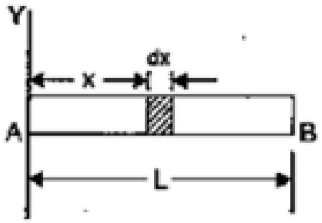

Fig. 3

4. (a) A steel bar 500mm long and 32mm is diameter is subjected to an axial tensile load of 70kN. If the modulus of elasticity is 200GPa and poisson's ratio 0.3. Calculate:

(i) Change in diameter and length;

(ii) Principal stresses and volumetric stress:;

(iii) Principal strains;

(iv) Bulk modulus and modulus of rigidity;

(v) Volumetric strain and change in volume. [7]

(b) A simple beam with a uniform load, w_1=10 kN/m and Spain of 18 shown in fig.4. Draw the shear and moment diagrams for this beamand find maximum moment and maximum shear. [7]

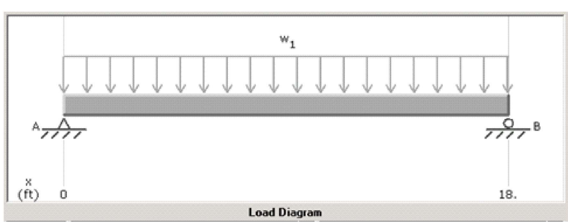

Fig.4

UNIT-III

5. Draw SFD and BMD for the single side overhanging beamsubjected to loading as shown below. Mark salient points onSFD and BMD. [5+5+4]

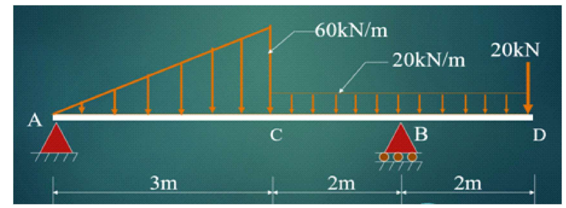

Fig.5

6. Draw SFD and BMD for the beam as shown in the Fig.6, also find the point of contraflexure, if any. [5+5+4]

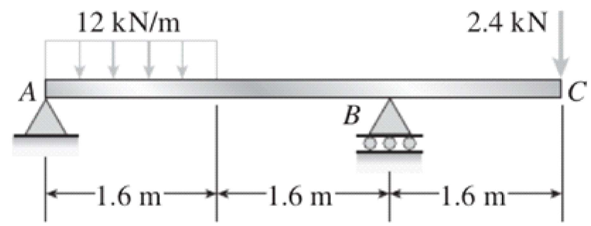

Fig.6

UNIT-IV

7. Two forces are applied to the bracket BCD as shown. (a) Knowing that the control rod AB is to be made of a steel having an ultimate normal stress of 600 MPa. determien the diameter of the rod for which the factor of safety with respect of failure will be 3.3 (b) The pin at C is to be made of a steel having an ultimate shearing stress of 350 MPa. Determine the diameter of the pin C for which the factor of safety with respect to shear will also be 3.3 (c) Determmine the required thickness of the brackets supports at C knowing that the allowable bearing stress of the steel used is 300 MPa. [5+5+4]