KATHMANDU UNIVERSITY
End Semester examination
May/June, 2022

Marks Scored:

Level : B.Tech.
Year : II
Course : ENVE 205
Semester : II

Exam Roll No :
Time: 30 mins
F.M : 20

Registration No:
Date :

SECTION "A"
[20Q. × 1 = 20 marks]

Encircle the most appropriate option.

1. A pin-jointed plane frame is unstable if (where m is number of members, r is reaction components and j is number of joints)
   a. $m + r = 2j$ b. $(m + r) < 2j$ c. $(m + r) > 2j$ d. none of the above

2. The layer at the center of gravity of the beam as shown in the Figure 1, will be
   a. In tension
   b. In compression
   c. Tension and compression
   d. Neither in tension nor in compression

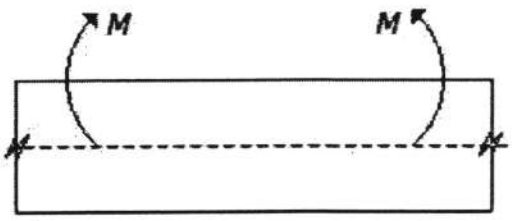


Figure 1

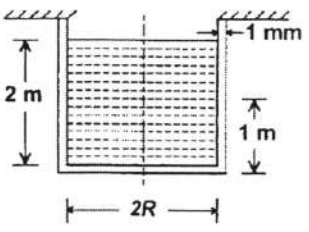
3. Degree of static indeterminacy of a rigid-jointed plane frame having 15 members, 3 reaction components and 14 joints is
   a. 2 b. 3 c. 6 d. 8

4. In the torsion equation $T/J = fs/R = G.\theta/ L$, the term J/R is called
   a. Section modulus b. Polar modulus c. Shear modulus d. None of these

5. A simply supported beam carries uniformly distributed load of 20 kN/m over the length of 5 m. If flexural rigidity is 30000 kN-m^2, what is the maximum deflection in the beam?
   a. 1.08 mm b. 6.2 mm c. 8.6 mm d. 5.4 mm

6. The parallel axis theorem gives the moment of inertia _____ to the surface of considerance.
   a. Perpendicular b. Non-Linear c. Parallel d. Linear

7. A cylindrical container of radius R= 1 m, wall thickness 1 mm is filled with water up to a depth of 2 m and suspended along its upper rim. The density of water is 1000 kg/m^3 and acceleration due to gravity is 10 m/s^2.
   If the young's modulus and Poisson's ratio of the container material are 100 GPa and 0.3, respectively the axial stress in the cylinder wall at mid depth is _____.
   a. 0.5×10^4 b. 1×10^4 c. 1.5×10^4 d. 2×10^4



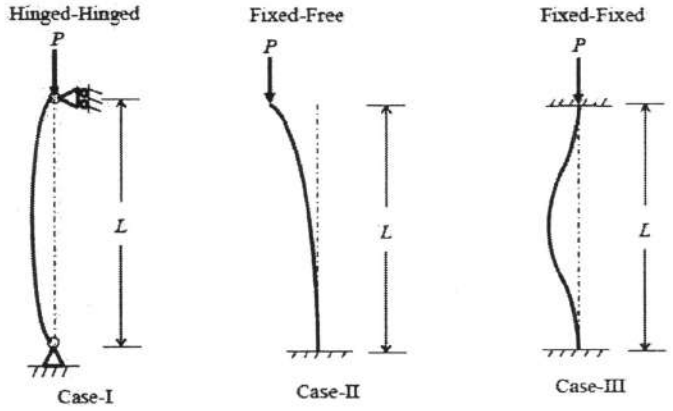
8. A thin cylinder (thickness, t and diameter, d) with closed ends is subjected to an internal pressure, p. The ratio of hoop stress to longitudinal stress developed in the wall of the cylinder is _____.

a. 1:4 b. 1:2 c. 1:1 d. 2:1

9. A steel rod is fixed at one end and free at the other end. The coefficient of thermal expansion of the steel is α, and modulus of elasticity is E. If the temperature of the rod is increased by Δt then the stress and strain developed in the rod are respectively

a. zero, $\alpha\Delta t$ b. $E\alpha\Delta t$, $\alpha\Delta t$ c. $E\alpha\Delta t$, zero d. zero, zero

10. The effective lengths of the columns with ideal boundary conditions shown in Case-I, Case-II, and Case-III are respectively



a. L, 4L, 2L b. L, 2L, L/4 c. L, L, L d. L, 2L, L/2

11. At a point in a stressed body, sum of the normal stresses acting on perpendicular faces of an arbitrarily oriented plane stress element is always _____.

a. Constant and independent of angle of orientation of the element
b. Dependent on the angle of orientation of the element
c. One half of the sum of the principal stresses
d. Zero

12. A compressive member always tends to buckle in the direction of _____.

a. Axis of load b. minimum cross-section
c. Least radius of gyration d. perpendicular to the axis of load

13. The torque transmitted by a solid shaft of diameter (D) is _____.

a. $\frac{\pi}{4} \times \tau \times D^3$ b. $\frac{\pi}{32} \times \tau \times D^3$ c. $\frac{\pi}{64} \times \tau \times D^3$ d. $\frac{\pi}{16} \times \tau \times D^3$

14. If M, I and R denote the bending moment, the moment of inertia and the radius of curvature of the beam, which of the following equations is correct

a. $\frac{1}{R} = \frac{d^2y}{dx^2} = \frac{EI}{M}$ b. $\frac{1}{R} = \frac{d^2y}{dx^2} = \frac{M}{EI}$ c. $R = \frac{d^2y}{dx^2} = \frac{M}{EI}$ d. $R = \frac{d^2y}{dx^2} = \frac{EI}{M}$

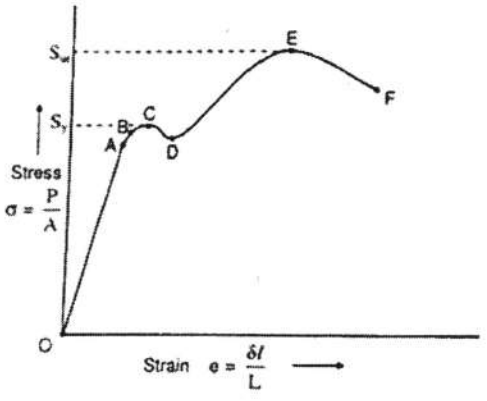
15. What is the formula of theorem of perpendicular axis?

a. $I_{zz} = I_{xx} - I_{yy}$ b. $I_{zz} = I_{xx} + Ah^2$ c. $I_{zz} - I_{xx} = I_{yy}$ d. None of these

16. The maximum _____ stresses occur at top most fibre of a simply supported beam.
a. Tensile b. Compressive c. Shear d. Bending

17. If a shaft diameter d is subjected to bending moment M, the bending stress (σ_b) induced in the shaft is by _____.
a. $\sigma_b = \frac{32\,M}{\pi d^3}$ b. $\sigma_b = \frac{16\,M}{\pi d^3}$ c. $\sigma_b = \frac{32\,M}{\pi d^2}$ d. $\sigma_b = \frac{64\,M}{\pi d^4}$

18. In stress strain curve up to point _____ material behaves in an elastic manner.
a. A b. B
c. C d. D



19. Bulk modulus is the ratio of _____.
a. Direct stress to linear strain
b. Direct stress to lateral strain
c. Direct stress to volumetric strain
d. Direct stress to shear strain

20. The point of contra flexure in a loaded beam in the point where _____.
a. The bending moment is maximum
b. The bending moment changes sign
c. The shear force changes sign
d. None of the above

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SECTION "B"

Attempt *ALL* questions. Assume suitable data if necessary.

1. Explain the principal plane and principal stress taking reference of an inclined plane of a body. A rectangular block 25 cm × 10 cm × 8 cm (Figure 1) is subjected to axial load as follows: Assuming Poisson's ratio as 0.25 find in terms of the modulus of elasticity E of the material the strains in the direction of each force. If E = 2 × 10^6 kg /cm^2. Find the value of the modulus of rigidity and bulk modulus for the material of the block. Also calculate the changes in the dimension and volume of the block due to the application of the loading specified above. [2+7 = 9]

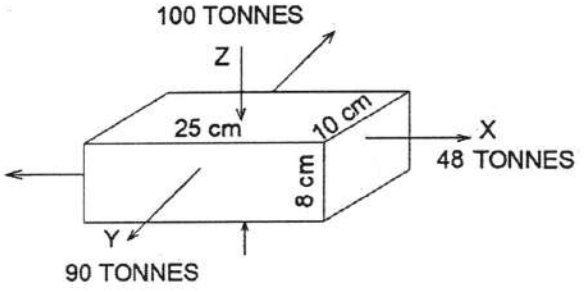

Figure 1

2. Determine the orientation of principal axes and principal moment of inertia about centroidal axes of the composite section shown in Figure 2. [6]

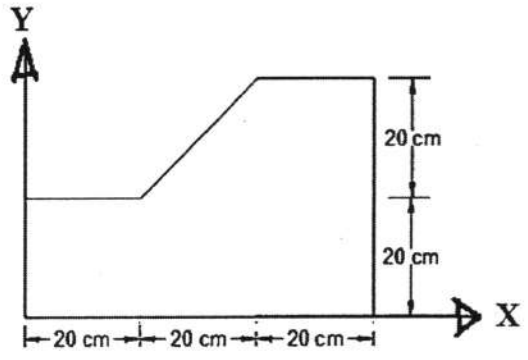

Figure 2

3. Prove that longitudinal stress is half of the circumferential stress for the thin cylinder with neat sketch. A steel tube in Figure 3 having inside and outside diameter of 40 mm and 45 mm respectively is firmly plugged at both ends, leaving an internal length of 250 mm between the flat ends of the plugs. The plugs are designed so that, water can be admitted to the inner space and also so that an axial pull can be applied to the tube. If the tube is subjected to an axial pull 40 kN and in addition is filled with water at a gauge pressure of 1.75 N/mm^2, Find the change in the volume of the tube. Take E for steel = 2×10^5 N/mm^2 and $1/m = 0.286$. [3+5=8]

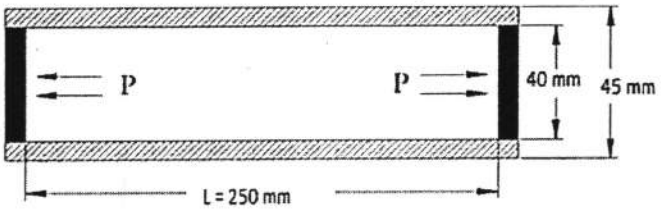

Figure 3

4. Show that hollow shaft is stronger than solid shaft, when material, weight and length are same. A horizontal shaft in Figure 4 is securely fixed at each ends has a full length of 11.25 m viewed from end A of the shaft, axial couples of 30 kN-m clockwise and 37.5 kN-m counterclockwise act on the shaft at a distance 4.5 m and 7.5 m from left respectively. Determine the end fixing couples in magnitude and direction and find the diameter of the shaft (solid) for maximum shearing stress of 60 N/mm^2. [2+6 =8]

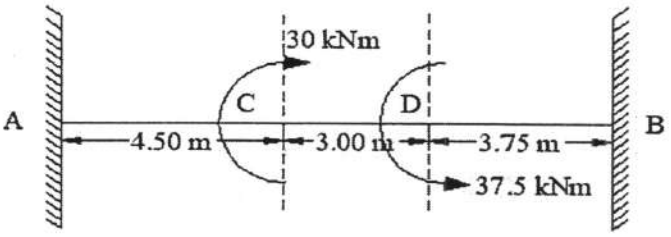

Figure 4

5. Prove that the neutral passes through the centroid of beam under pure bending moment. Determine the variation of horizontal shear stress for following section shown Figure 5 when shear force is 50 kN. [2+7 = 9]

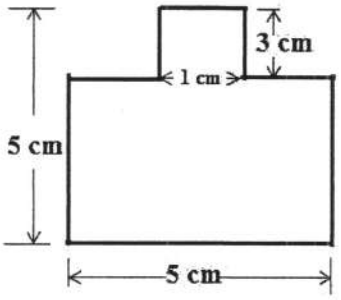

Figure 5

6. Explain the limitation of Euler's theory of buckling of column. A cast iron-hollow cylinder column is 4m long and hinged at both ends and its critical buckling load is P kg. When the same column is fixed at both ends, its critical load rises to (P+5000) kg. If the ratio of external internal diameter is 1.3 and E = 1.0 x 10^6 kg/cm^2. Determine the external diameter of column. [7]

7. Draw axial force, shear force and bending moment diagrams for the frame as in Figure 6 indicating the principal numerical values at salient point. [8]

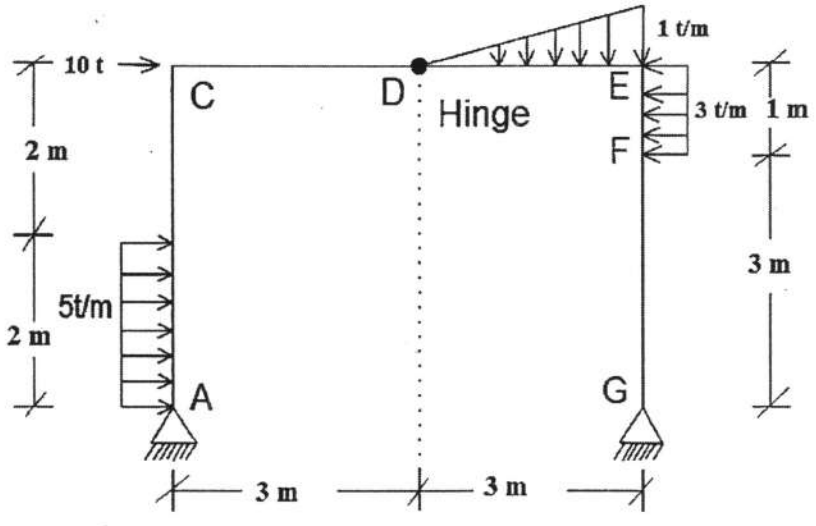

Figure 6