KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2025

Marks Scored:

Level : B.E.
Year : II

Course : CIEG 208
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : 02 MAR 2025

SECTION "A"

[20 Q. × 0.5 = 10 marks]

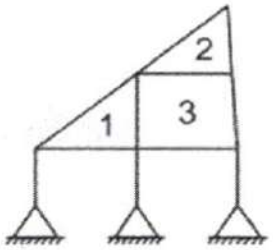
Choose and encircle the most appropriate option from each set of choices

1. A structure is said to be statically indeterminate when
   a. The number of equilibrium conditions exceeds the number of unknown reaction components
   b. The number of equilibrium conditions equal to the number of unknown reaction components
   c. The reaction and internal stress can be determined using the static equilibrium equations
   d. The number of unknown reaction components exceeds the number of equilibrium conditions

2. Consider the following statements:
   i. Linear elastic bodies
   ii. Bodies subjected to small deformations

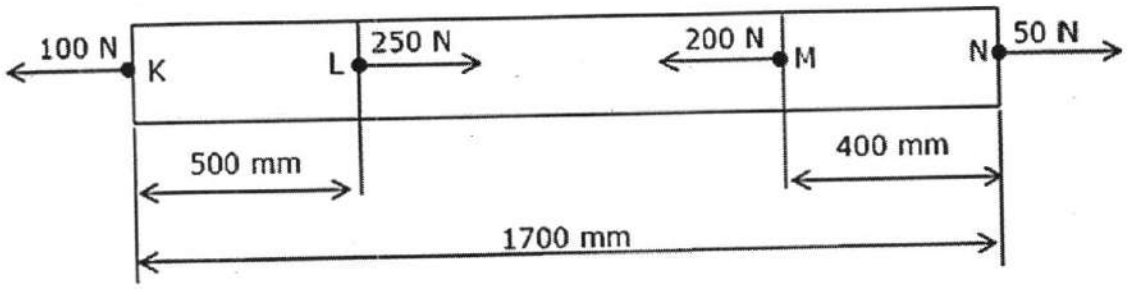
   Which of these statements is/are correct?
   a. 1 alone b. 1 and 2 c. 2 alone d. Either 1 or 2

3. The total (both external and internal) degrees of indeterminacy of the structure shown in the figure is
   a. 9
   b. 10
   c. 12
   d. 13



4. A rod of length L and diameter D is subjected to a tensile load P. Which of the following is sufficient to calculate the resulting change in diameter?
   a. Young's modulus
   b. Shear modulus
   c. Poisson's ratio
   d. Both Young's modulus and shear modulus

5. The figure below shows a steel rod of 25 mm2 cross sectional area. It is loaded at four points, K, L, M and N. Assume $Es = 200\ GPa$. The total change in length of the rod due to loading is:



a. 1 μm b. -10 μm c. 16 μm d. -20 μm

6. The stretch in a steel rod of circular section, having a length $'l'$ subjected to a tensile load $'w'$ and tapering uniformly from a diameter a_1 at one end to a diameter a_2 at the other end, is given.

a. $\frac{wl}{4Ea_1a_2}$ b. $\frac{wl\pi}{Ea_1a_2}$ c. $\frac{wl\pi}{4Ea_1a_2}$ d. $\frac{wpl}{\pi Ea_1a_2}$

7. A bar of copper and steel form a composite system. They are heated to a temperature of $40\ ^\circ C$. What type of stress is induced in the copper bar? $(\alpha_c > \alpha_s)$.

a. Tensile b. Compressive
c. Both tensile and compressive d. Shear

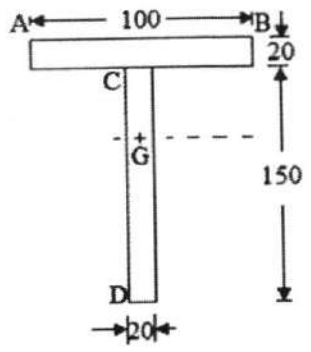
8. A block of steel is loaded by a tangential force on its top surface while the bottom surface is held rigidly. The deformation of the block is due to

a. Shear only b. Bending only c. Shear and bending d. Torsion

9. A concentrated load of P acts on a simply supported beam of span L at a distance $L/3$ from the left support. The bending moment at the point of application of the load is given by:

a. $\frac{PL}{3}$ b. $\frac{2PL}{3}$ c. $\frac{PL}{9}$ d. $\frac{2PL}{9}$

10. A T-beam shown in the given figure is subjected to a bending moment such that plastic hinge forms. The distance of the neutral axis from D is (all dimensions are in mm)



a. Zero b. 109 mm c. 125 mm d. 170 mm

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11. The area moment of inertia of a square of size 1 unit about its diagonal is:
a. 1/3 b. 1/ 4 c. 1/12 d. 1/ 6

12. In I-Section of a beam subjected to transverse shear force, the maximum shear stress is developed.
a. At the center of the web
b. At the top edge of the top flange
c. At the bottom edge of the top flange
d. None of the above

13. For a simply supported beam of span L subjected to a UDL of intensity $w\ kN/m$, the maximum deflection is given by:
a. $WL^4/48EI$ b. $WL^4/24EI$ c. $WL^4/8EI$ d. $5WL^4/384EI$

14. A solid circular shaft of 60 mm diameter transmits a torque of $1600\ N-m$. The value of maximum shear stress developed is:
a. 47.72 MPa b. 57.72 MPa c. 37.72 MPa d. 67.72 MPa

15. A solid shaft transmits a torque T. The allowable shearing stress is τ . What is the diameter of the shaft?
a. $\sqrt[3]{\frac{16T}{\pi\tau}}$ b. $\sqrt[3]{\frac{32T}{\pi\tau}}$ c. $\sqrt[3]{\frac{16T}{\tau}}$ d. $\sqrt[3]{\frac{T}{\tau}}$

16. The maximum principal strain in a thin cylindrical tank, having a radius of 25 cm and wall thickness of 5 mm when subjected to an internal pressure of 1MPa, is (taking Young's modulus as 200 GPa and Poisson's ratio as 0.2).
a. 2.25×10^{-4} b. 2.25 c. 2.25×10^{-6} d. 22.5

17. The volumetric strain in case of a thin cylindrical shell of diameter d, thickness t, Subjected to internal pressure p is:
a. $\frac{pd}{2tE}(3-2\mu)$ b. $\frac{pd}{3tE}(4-3\mu)$ c. $\frac{pd}{4tE}(5-4\mu)$ d. $\frac{pd}{4tE}(4-5\mu)$

18. If one end of a hinged column is made fixed and the other free, how much is the critical load compared to the original value?
a. ¼ b. ½ c. Twice d. Four times

19. The buckling load will be maximum for a column, if
a. One end of the column is clamped and the other end is free
b. Both ends of the column are clamped
c. Both ends of the column are hinged
d. One end of the column is hinged and the other end is free

20. A metal pipe of 1m diameter contains a fluid having a pressure of $10\ kgf/cm^2$. If the permissible tensile stress in the metal is $200\ kgf/cm^2$, then the thickness of the metal required for making the pipe would be:
a. 5 mm b. 10 mm c. 20 mm d. 25 mm

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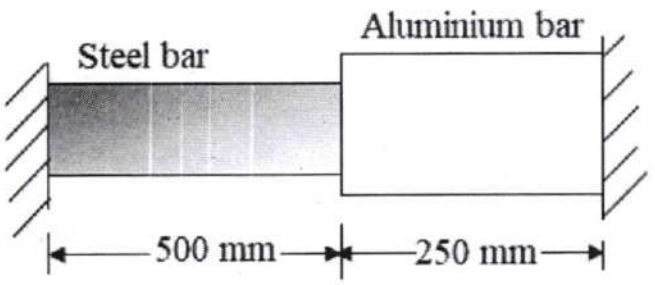
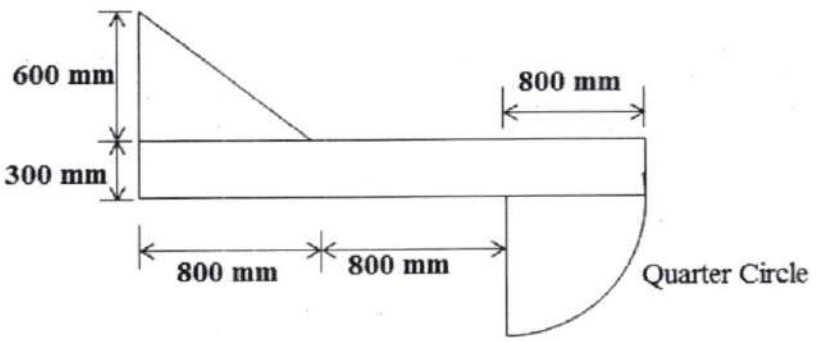
SECTION "B"

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

1. Derive the formula for normal and tangential stresses on an inclined plane in an element subjected to pure shear stress. A composite bar made up of aluminium and steel is held between two supports as shown below. The bars are stress free at a temperature of 42°C. What will be the stresses in the two bars when the temperature drops to 24°C, if (a) supports are unyielding (b) the supports come nearer to each other by 0.1 mm. The cross-sectional area of steel bar is 160 mm^2 and that of aluminium bar is 240 mm^2. Take E for aluminium as $0.7 \times 10^5\ N/mm^2$ and that for steel as $2 \times 10^5\ N/mm^2$. The coefficients of thermal expansion for alumimium and steel are 24×10^{-6} per ^oC and 24×10^{-6} per ^oC respectively. [3+5=8]



2. Determine the orientation of principal axes and principal moment of inertia about centroidal axes of the composite section shown in figure. ***All dimensions are in mm.*** [6]



3. A solid shaft is to transmit 300 kW at 120 r.p.m. If the shear stress is not to exceed 100 MPa. Find the diameter of the shaft, what percent saving in weight would be obtained if this shaft were replaced by a hollow one whose internal diameter equals 0.6 of the external diameter, the length, material and maximum allowable shear stress being the same? [2+2=4]

4. Prove that the neutral axis aligns with the centroidal axis, with an example. A timber beam 150 mm wide and 200 mm deep is to be reinforced by bolting on two flitched each 150 mm × 12.5 mm in section. Find the moment of resistance when [1+6=7]
   a. The flitched are attached symmetrically at the top and bottom
   b. Flitched are attached at the sides.

   Allowable stress in timber is 6 N/mm^2, Es = 20 Ew).

5. A cylindrical vessel is 1.5 m diameter and 4 m long is closed at ends by rigid plates. It is subjected to an internal pressure of 3 N/mm^2. If the maximum principal stress is not to exceed 150 N/mm^2, find the thickness of the shell. Assume $2 \times 10^5\ N/mm^2$ and Poisson's ratio = 0.25. Find the changes in diameter, length and volume of the shell. [4]

6. A simply supported beam of length 4 meter is subjected to a uniformly distributed load of 30 kN/m over the whole span and deflects 15 mm at the centre. Determine the crippling loads when this beam is used as a column with the following conditions:
   a. One end fixed and other end hinged [4]
   b. Bothe the ends pin jointed

7. Draw axial force, shear force and bending moment diagrams for the frame shown in figure indicating the principal numerical values at salient point if any. [7]