BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

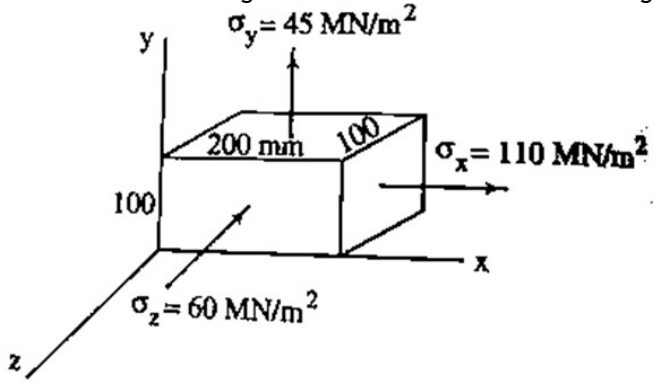
CLASS: BTECH **SEMESTER : III**
BRANCH: CIVIL **SESSION : MO/2025**

SUBJECT: CE24201 MECHANICS OF SOLIDS

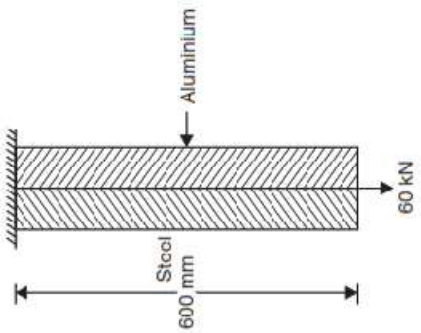
TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	A rectangular block of steel of dimensions 100 mm × 100 mm × 200 mm is subjected to stresses of 110 MN/m² (tensile), 60 MN/m² (compressive), and 45 MN/m² (tensile) across three pairs of faces. If the Poisson's ratio is v = 1/3, and the modulus of elasticity is E = 213 GN/m², calculate the strain and the change in length in all directions. Also calculate the change in volume of the bar. Refer to Fig. below	[2] [2] [1]	CO1	Analyze



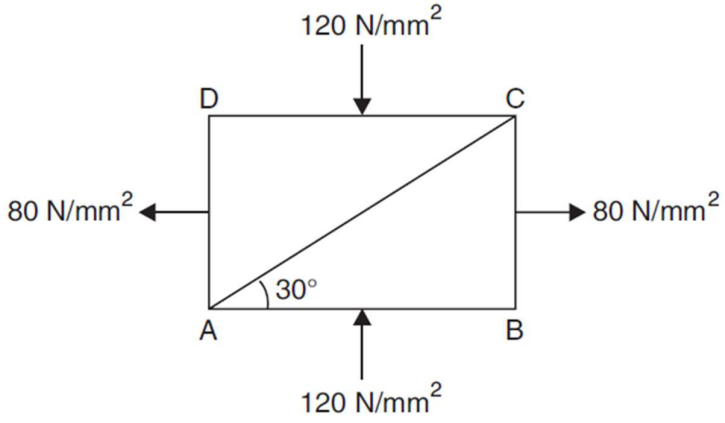
Q.1(b)	A compound bar of length L = 600 mm consists of two strips rigidly joined along their length: Aluminium strip: =40mm, thickness =20mm Steel strip: width =60mm, thickness =15mm The two strips are rigidly joined at the ends and subjected to an axial tensile force P=60kN. The elastic moduli are Ea=1×10^5N/mm² (aluminium) and Es=2×10^5N/mm² (steel). Determine: i. The stresses developed in the aluminium and in the steel. ii. The extension of the compound bar.	[3] [2]	CO1	Analyze



PTO

Q.2(a) The direct stresses at a point in a strained material are 120 N/mm² (compressive) and 80 N/mm² (tensile) in mutually perpendicular directions, as shown in the figure. There is no shear stress on these reference planes. Find:
i. The normal stress on the plane AC.
ii. The tangential (shear) stress on the plane AC.
iii. The resultant stress on AC.

[2] [2] [1] CO2 Apply



Q.2(b) At a point, two mutually perpendicular planes carry normal stresses 75 MN/m² (tensile) and 45 MN/m² (compressive), each accompanied by a shear stress. If the major principal stress is 105 MN/m² (tensile), determine:

i. The shear stress on the two given planes,
ii. The minor principal stress,
iii. The maximum shear stress at the point.

[2] [2] [1] CO2 Analyze

Q.3(a) A timber beam 100 mm wide × 300 mm deep spans 6 m. It is simply supported at A and B and carries a uniformly distributed load w (kN/m) over the full span. A point load 'P' acts at a point C located 1.5 m from B (i.e., 4.5 m from A). The maximum flexural stress is limited to 8 N.mm².
Determine:
1. The maximum uniform load w such that the zero shear occurs directly under the point load P.
2. The corresponding value of P.

[3] [2] CO3 Evaluate

Q.3(b) A simply supported timber beam with cross-section b x d = 150 mm x 300 mm spans L= 4.5 m and carries a uniformly distributed load w = 8 kN/m. Compute:
1. The shear stress on a layer 60 mm above the neutral axis at a section located x = 1.5 m from the left support.
2. The maximum shear stress at that section.
3. The maximum shear stress anywhere in the beam.

[2] [1] [2] CO3 Analyze

Q.4(a) Power P= 2250 kW is to be transmitted at a rotational frequency f = 1 Hz. The permissible shear stress is 80 N/mm².
1. Determine the necessary diameter of a solid circular shaft.
2. If a hollow circular shaft is used with internal diameter di = 0.75 d_o, determine the saving in mass per metre length of the shaft.

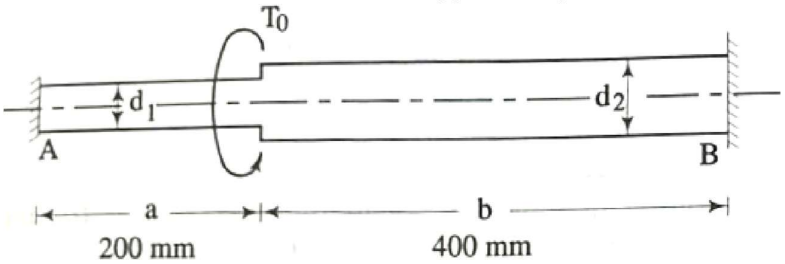
[3] [2] CO4 Evaluate

PTO

Q.4(b) For the stepped shaft shown *(built-in at both ends)*, the data are: [5] CO4 Evaluate

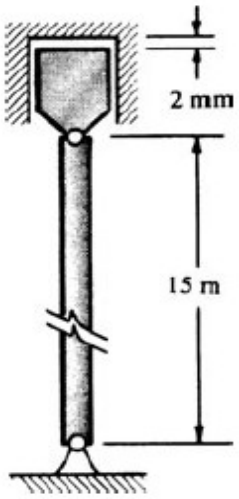
- Lengths: a = 200 mm, b = 400 mm
- Diameters: d_1 =25 mm, d_2 = 30 mm

An eccentric torque T_o is applied at the step between the two segments (see figure).
The allowable working shear stress is 56 N/mm^2.
Task: Calculate the safe value of the applied torque T_o .



Q.5(a) A steel bar with rectangular cross-section 40 mm × 50 mm, pinned at each end, is subjected to axial compression. [5] CO5 Apply
If the proportional limit of the material is 230 MPa and E = 200 GPa, determine the minimum length for which Euler's equation may be used to determine the buckling load.

Q.5(b) The column shown in Fig. is pinned at both ends and is free to expand into the opening at the upper end. [5] CO5 Analyze
The bar is steel, 25 mm in diameter, and occupies the position shown at 16 °C.
Determine the temperature to which the column may be heated before it will buckle.
Take thermal expansion coefficient = 12 x 10^{-6} /ºC and Young's modulus = 200 GPa. Neglect the weight of the column.



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