R/K/TY

Reg. No: 24BMEE0272

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: BMEE202L - Mechanics of Solids
Class NBR(s): 2080 / 2082 / 2083 / 2084 / 2089 / 2091 Slot: A2+TA2
Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction: Assume any missing data, suitably and tabulate your final results.

COs	CO Statements
CO1	Analyse stresses and strains in simple and compound bars, the importance of principal stresses, principal planes and failure theories.
CO2	Illustrate the relationship among load, shear force and bending moment for various beams.
CO3	Evaluate the bending and shear stresses for beams with varying cross sections.
CO4	Calculate the slope and deflection of various beams.
CO5	Apply torsion equation for shafts and helical springs.
CO6	Analyse the failure of columns, thin and thick shells.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. Figure 1. shows a beam AB of length 4 m acted upon by the forces and moments. Draw the B.M. and S.F. diagrams. **CO2 BL3**

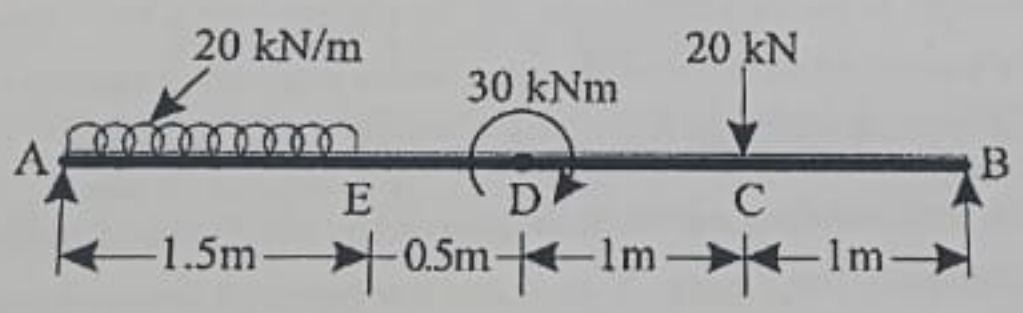

Figure 1

2. *Figure 2 shows a T-beam (120 mm deep) used as a beam with simply supported ends, so that the flange comes under tension (CG is mark as point "G" in the figure 2. The material of the beam can be subjected to 75 MN/m² in compression and 25 MN/m² in tension. It is desired to achieve a balanced design so that the largest possible bending stresses are reached simultaneously. Find:* **CO3 BL4**

(i) The width of the flange.

(ii) The magnitude of concentrated load that can be applied to the beam at its centre if the span length is 6 m.

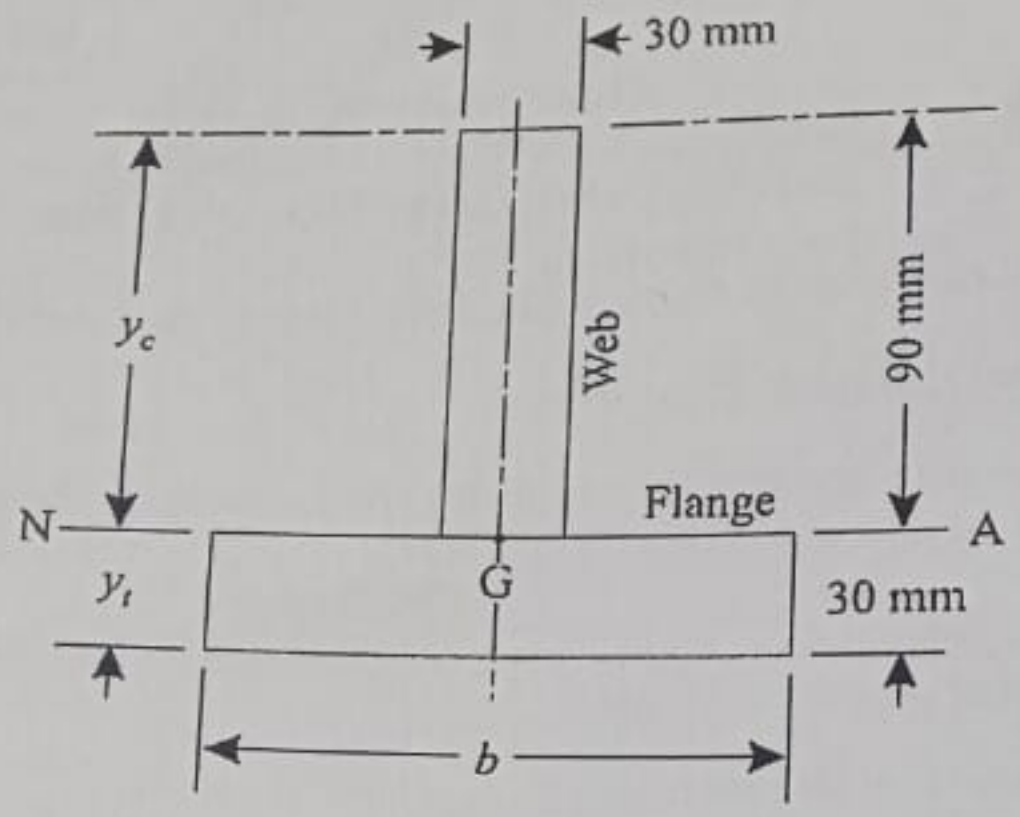

Figure 2

3. A steel girder of 6 m length acting as a beam carries a uniformly distributed load w N/m run throughout its length. If $I = 30 \times 10^{-6}$ m^4 and depth 270 mm, using the double integration method, calculate: **CO4** **BL3**

(i) The magnitude of *w* so that the maximum stress developed in the beam section does not exceed 72 MN/m^2.

(ii) The slope and deflection (under this load) in the beam at 1.8 m from the left end.

Take : $E = 200$ GN/m^2

4. A solid shaft of mild steel 200 mm in diameter is to be replaced by hollow shaft of alloy steel for which the allowable shear stress is 22 percent greater. If the power to be transmitted is to be increpased by 20 percent and the speed of rotation increased by 6 percent determine the maximum internal diameter of the hollow shaft. The external diameter of the hollow shaft is to be 200 mm. **CO5** **BL3**

5. Sketch the shear force and bending moment diagrams showing salient values for the beam loaded as shown in the Figure. 3. Indicate the point of contraflexure. **CO2** **BL3**

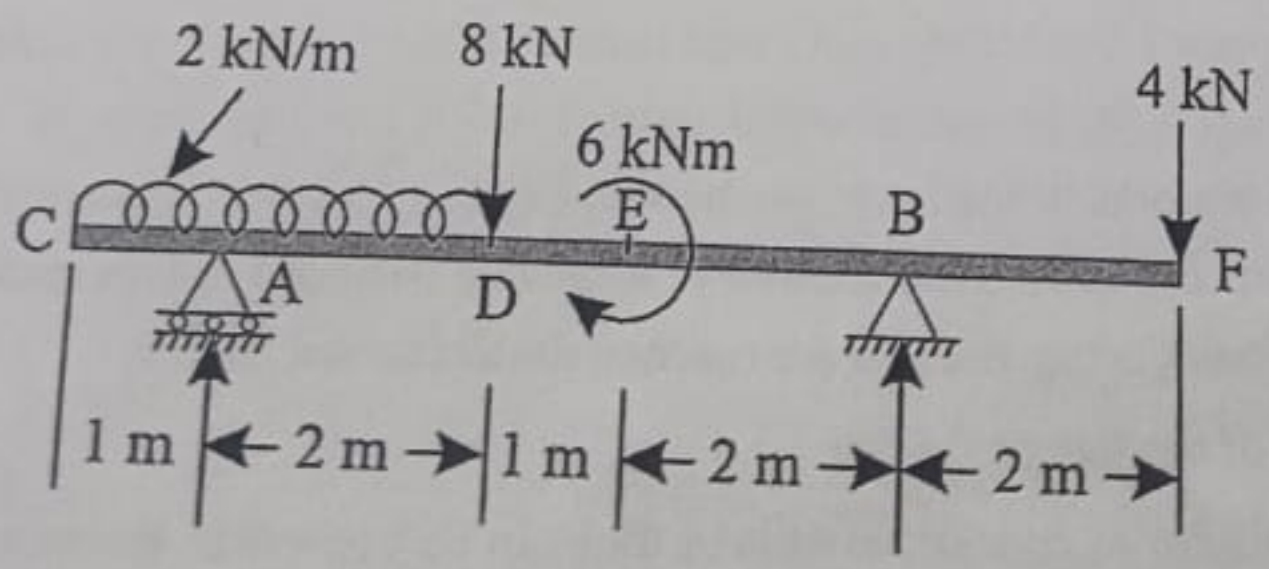

Figure 3

6. An I-section beam 340 mm × 200 mm has a web thickness of 10 mm and flange thickness of 20 mm (Figure. 4). It carries a shearing force of 100 kN. Sketch the shear stress distribution across the section. CO3 BL3

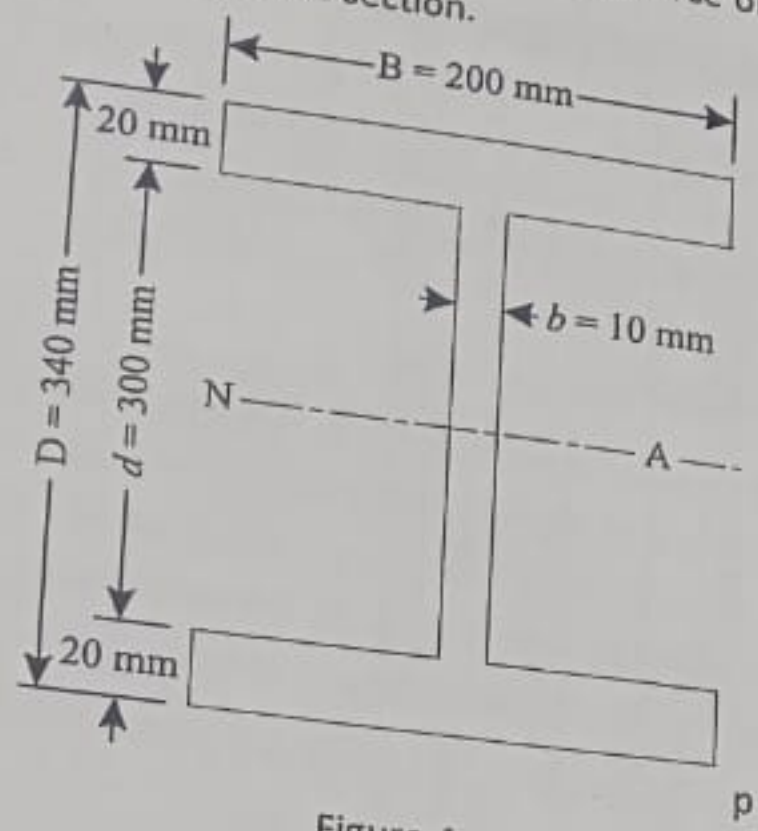

Figure 4

7. A steel girder of uniform section, 14 metres long is simply supported at its ends. It carries concentrated loads of 90 kN and 60 kN at two points 3 m and 4.5 m from the left and right ends respectively. Calculate (use Macaulay's method): CO4 BL3

(i) The deflection of the girder at the points under the two loads.

(ii) The maximum deflection.

Take: $I = 64 \times 10^{-4}$ m^4 and $E = 210 \times 10^{-6}$ kN/m^2.

8. A solid phosphor bronze shaft of 80 mm diameter is coupled to a hollow steel shaft 80 mm outside diameter. The torque applied to the compound shaft develops a maximum shear stress of 40 MN/m^2 in the bronze shaft and a maximum shear stress of 72 MN/m^2 in steel shaft. CO5 BL4

The length of steel shaft is 1 m and of bronze shaft is 1·2 m. Angle of twist for the steel shaft is not to exceed 1°. If C_{steel} = 80 GN/m^2 and C_{bronze} = 40 GN/m^2.

Find:

(i) Internal diameter of the steel shaft;

(ii) Total angle of twist for whole of the shaft.

9.a) Figure. 5 shows a round steel rod supported in a recess and surrounded by co-axial brass tube. The upper end of the rod is 0.1 mm below that of the tube and an axial load is applied to a rigid plate resting on the top of the tube. CO1 BL3

(i) Determine the magnitude of the maximum permissible load if the compressive stress in the rod is not to exceed 110 MN/m^2 and that in the tube is not to exceed 80 MN/m^2.

(ii) Find the amount by which the tube will be shortened by the load if the compressive stress in the tube is the same as that in the rod.

Take: E_s = 200 GN/m^2; E_b = 100 GN/m^2.

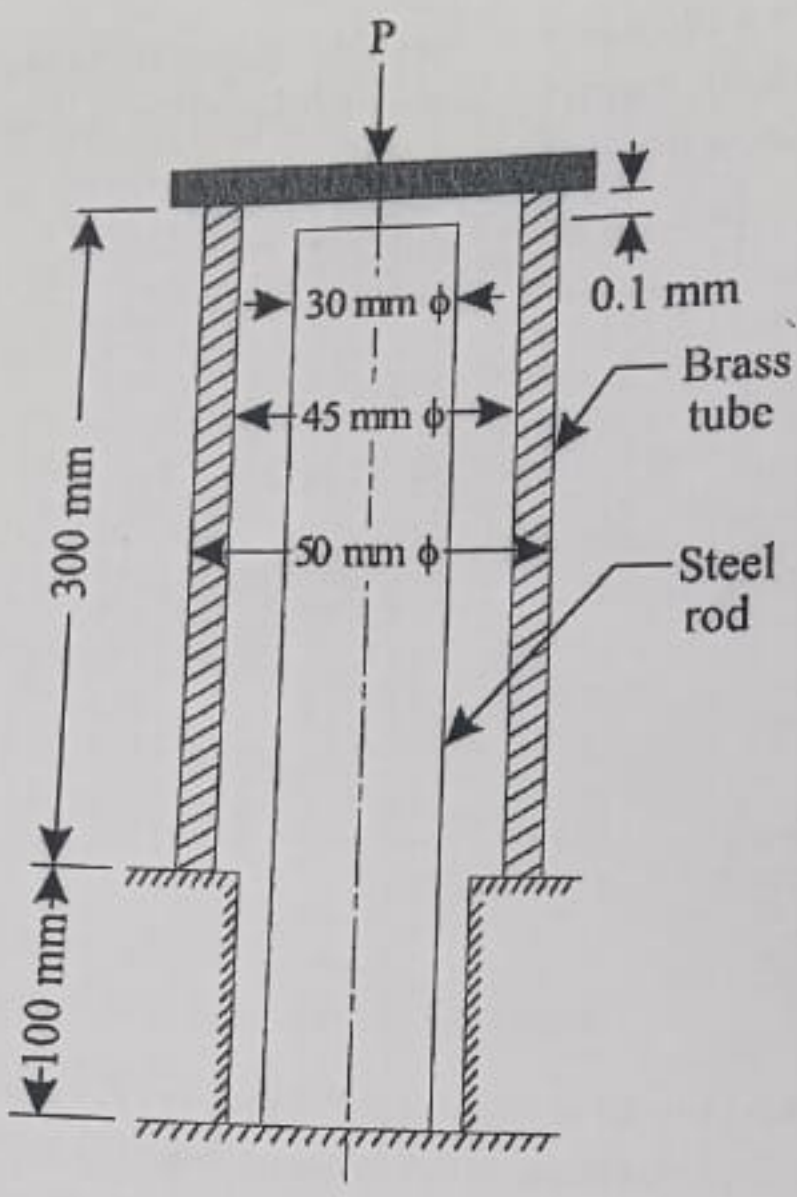

Figure 5

OR

9.b) At a point in a material under stress (Figure. 6), the intensity of the resultant stress on a certain plane is 50 MN/m² (tensile) inclined at 30° to the normal of that plane. The stress on a plane at right angles to this has a normal tensile component of intensity of 30 MN/m². **CO1** **BL3**

Find:

(i) The resultant stress on the second plane.

(ii) The principal planes and stresses.

(iii) The plane of maximum shear and its intensity.

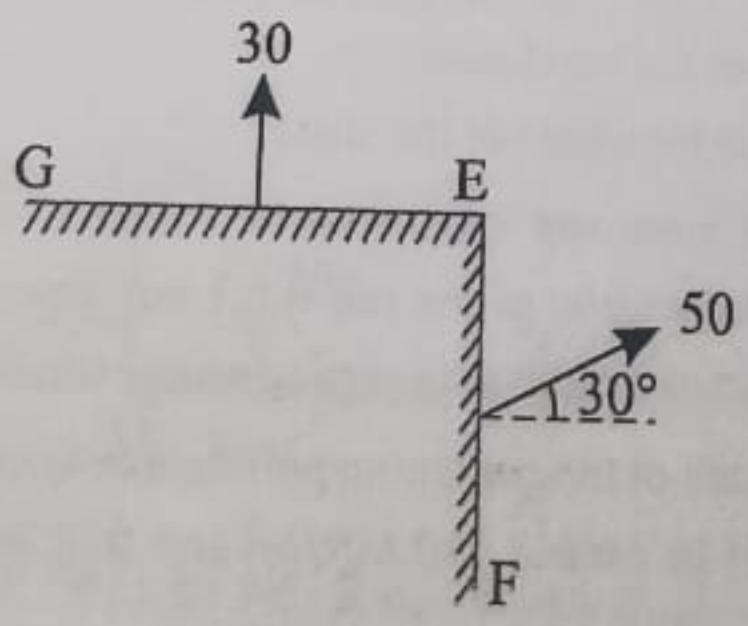

Figure 6

10.a) Compare the crippling loads given by Rankine's and Euler's formulae for tubular strut 2·25 m long having outer and inner diameters of 37·5 mm and 32·5 mm loaded through pin-joint at both ends. **CO6 BL3**

Take: Yield stress as 315 MN/m^2, a = 1/7500,

and E = 200 GN/m^2.

If elastic limit for the material is taken as 200 MN/m^2, then for what length of the strut does the Euler formula cease to apply?

OR

10.b) A boiler drum consists of a cylindrical portion 4 m long, 1·5 m in diameter and 2·25 cm thick. It is closed by hemispherical ends. In a hydraulic test to 6 MN/m^2, how much additional water will be pumped in after initial filling at atmospheric pressure? The circumferential strain at the junction of the cylinder and hemisphere may be assumed as same for both. **CO6 BL3**

E = 200 GN/m^2, K (for water) = 2.13 GN/m^2, and μ=0.3

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