Final Assessment Test – November 2025

VIT
Vellore Institute of Technology

Course: **BMEE202L - Mechanics of Solids**

Class NBR(s): **2076 / 2078 / 2081 / 2088 / 2090** Slot: **A1+TA1**

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**

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. The fixed-end bar ABCD shown in figure 1 is consists of three prismatic segments. The end segments have cross-sectional area $A_1 = 840\ mm^2$ and length $L_1 = 200$ mm. The middle segment has cross-sectional area $A_2 = 1260\ mm^2$ and length $L_2 = 250$ mm. Loads P_B and P_C are equal to 25.5 kN and 17.0 kN, respectively. (a) Determine the reactions R_A and R_D at the fixed supports. (b) Determine the compressive axial force F_{BC} in the middle segment of the bar. **CO1 BL3**

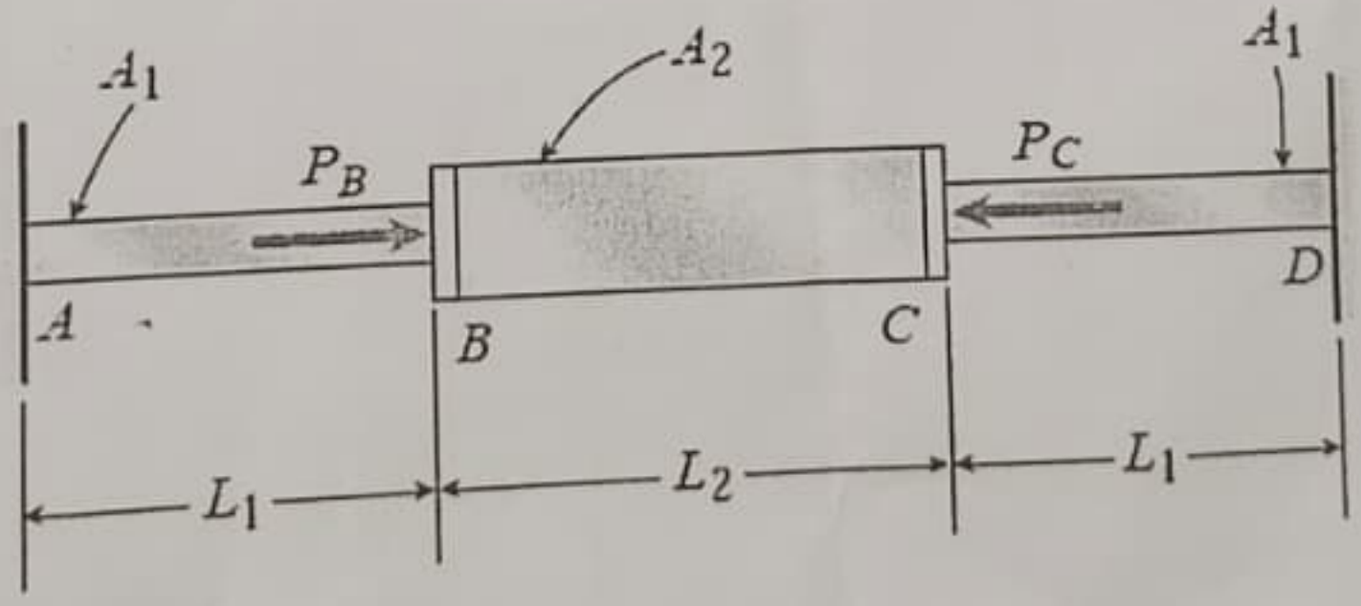

Figure. 1

2. For the state of plane stress considered in figure 2 determine (a) the principal stresses and principal planes (b) maximum shearing stress and the corresponding normal stress. **CO1** **BL3**

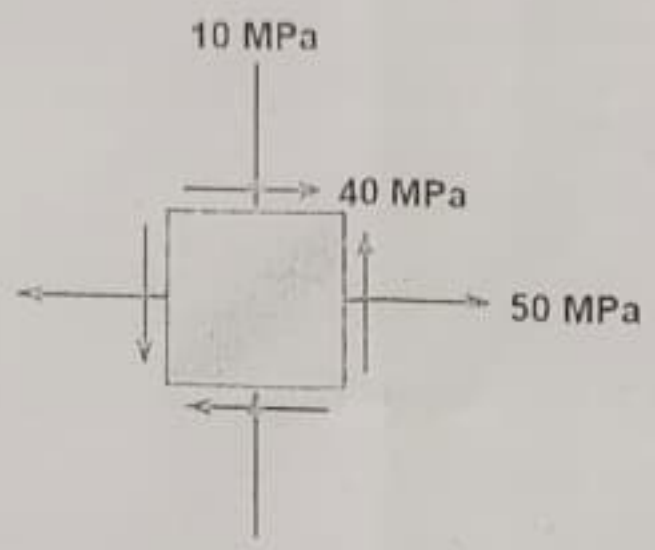

Figure 2

3. Draw the shear force and bending moment diagrams for a cantilever loaded as shown in Figure 3. **CO2** **BL3**

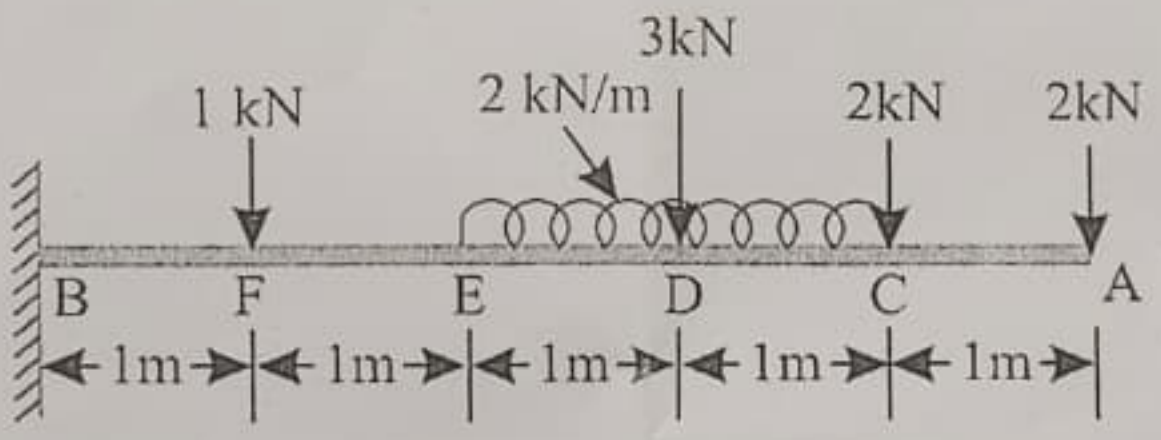

Figure 3

4. A bridge girder *AB* on a simple span of length $L = 14$ m supports a uniform load of intensity q that includes the weight of the girder (see figure 4). The girder is constructed of three plates welded to form the cross section shown. Determine the maximum permissible load q based upon (a) an allowable bending stress $\sigma_{allow} = 110$ MPa, and (b) an allowable shear stress $\tau_{allow} = 50$ MPa. **CO3** **BL4**

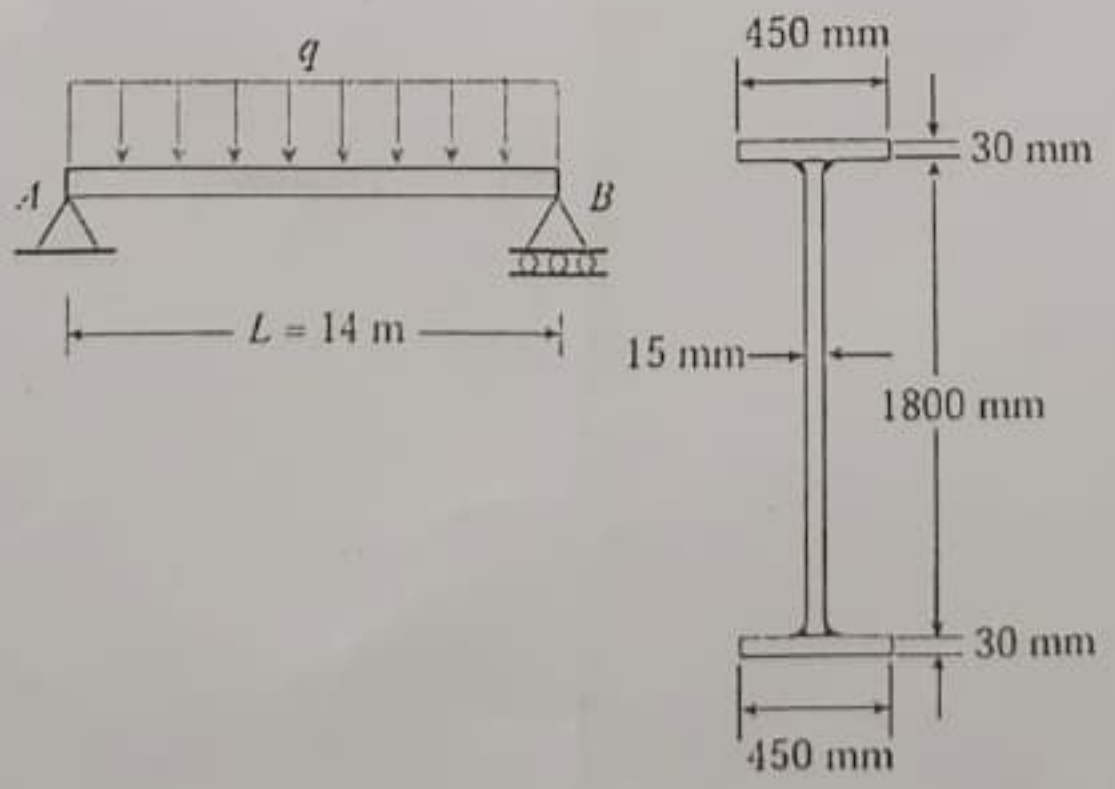

Figure 4

5. Determine the following for an overhanging beam ABC supported at A and B and loaded as shown in Figure 5. (i) Deflection at the free end C; (ii) Maximum deflection between A and B. Take: $E = 200 \times 10^6$ kN/m^2 and $I = 13.5 \times 10^{-6}$ m^4. CO4 BL4

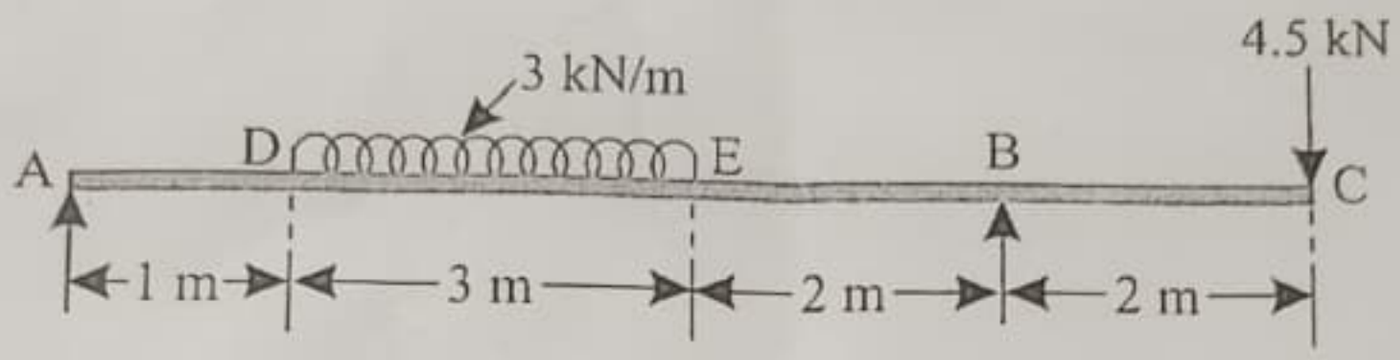

Figure 5

6. A solid steel shaft is subjected to a torque of 45 kNm. If the angle of twist is 0·5° per metre length of the shaft and the shear stress is not to be allowed to exceed 90 MN/m^2 find: (i) Suitable diameter for the shaft; (ii) Final maximum shear stress and angle of twist; and (iii) Maximum shear strain in the shaft. Take: C = 80 GN/m^2 CO5 BL3

7. A boiler shell is to be made of 15 mm thick plate having tensile stress of 120 MN/m^2. If the efficiencies of the longitudinal and circumferential joints are 70% and 30% respectively, determine: (i) Maximum permissible diameter of the shell for an internal pressure of 2 MN/m^2. (ii) Permissible intensity of internal pressure when the shell diameter is 1·5 m. CO6 BL4

8. A steel bar is placed between two copper bars, each having the same area and length as steel bar at 20°C. At this stage, they are rigidly connected together at both the ends. When the temperature is raised to 320°C, the length of the bars increases by 1.5 mm. Determine the original length and final stresses in the bars. Take *Es* = 220 GN/m^2; *Ec* = 110 GN/m^2. The value of co-efficient of linear expansion for steel and copper is given as 0.000012 per °C and 0.0000175 per °C respectively. CO1 BL3

9.a) Draw the shear force and bending moment diagrams for the beam shown loaded in Figure 6. CO2 BL3

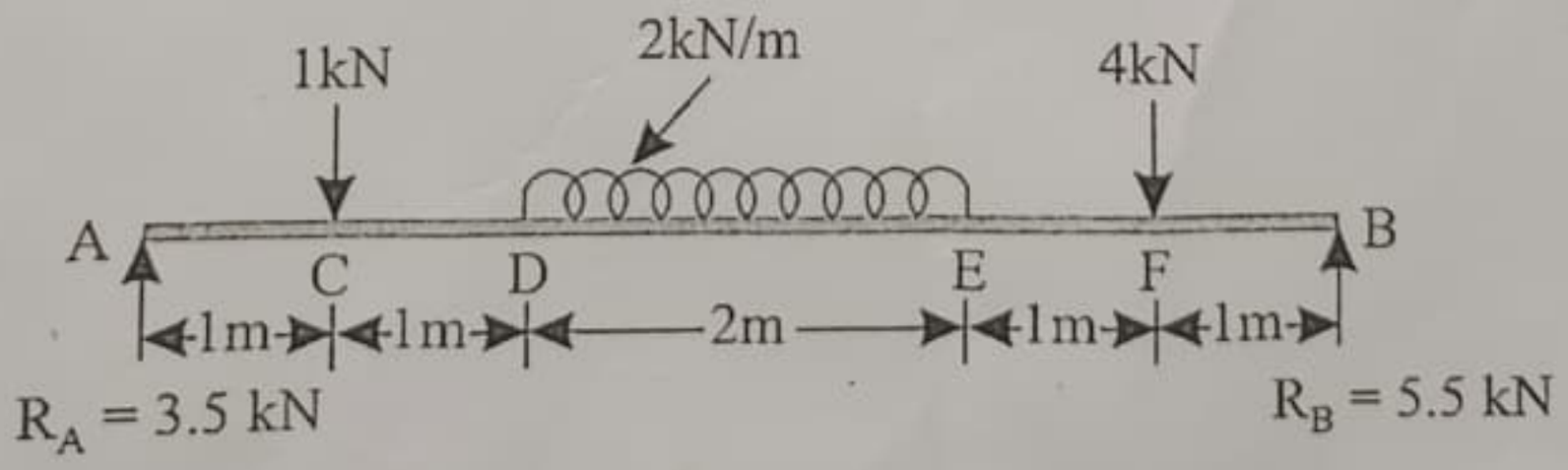

Figure 6

OR

9.b) Draw the shear force and bending moment diagrams for the beam shown loaded in Figure 7 **CO2** **BL3**

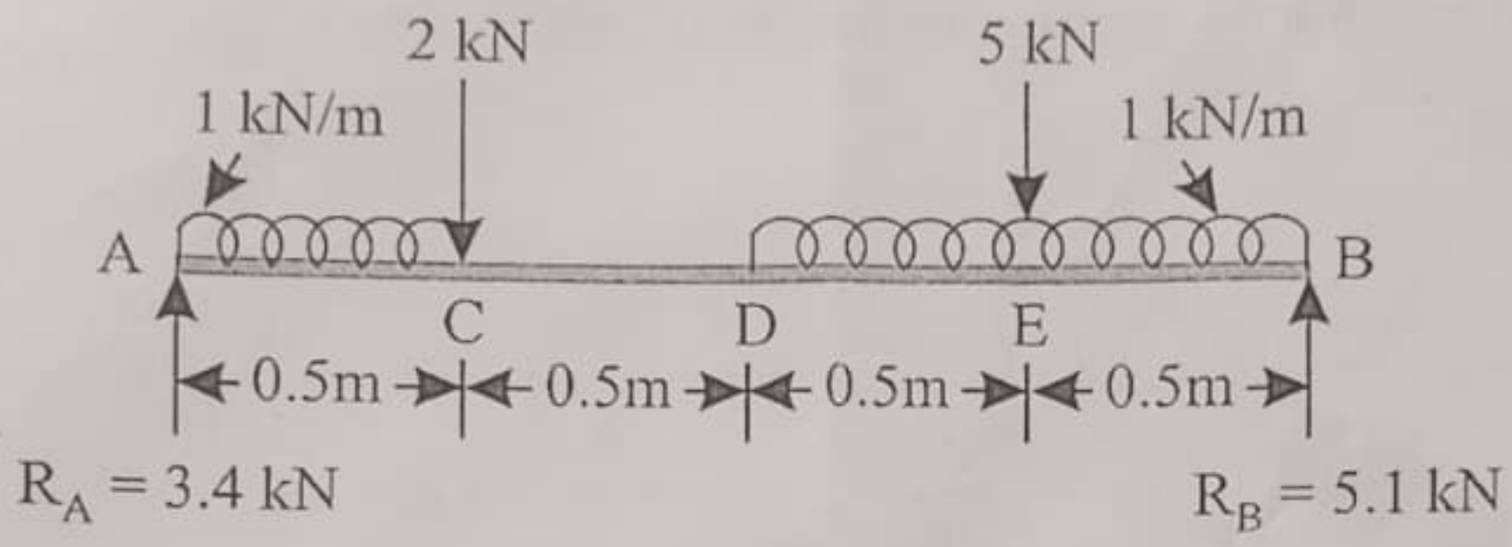

Figure 7

10.a) A steel pipe column (E = 210 GPa) with length L = 1.2 m has inside and outside diameters d_1 = 36 mm, and d_2 = 40 mm, respectively (see figure 8). The column is supported only at the ends and may buckle in any direction. Calculate the critical load P_{cr} for the following end conditions: (1) pinned-pinned, (2) fixed-free, (3) fixed pinned, and (4) fixed-fixed. **CO6** **BL4**

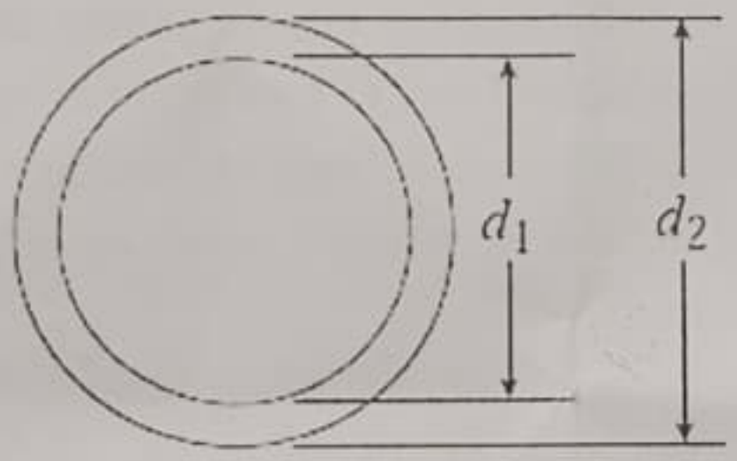

Figure 8

OR

10.b) A hollow C.I. column whose outside diameter is 200 mm has a thickness of 20 mm. It is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine-Gordon formula using a factor of safety of 4. **CO6** **BL4**

Take: $\sigma_c = 550$ MN/m^2; a = 1/1600.

⇔⇔⇔ **Q/K/TY** ⇔⇔⇔