MANIPAL INSTITUTE OF TECHNOLOGY

III SEMESTER B.TECH (CIVIL ENGINEERING)

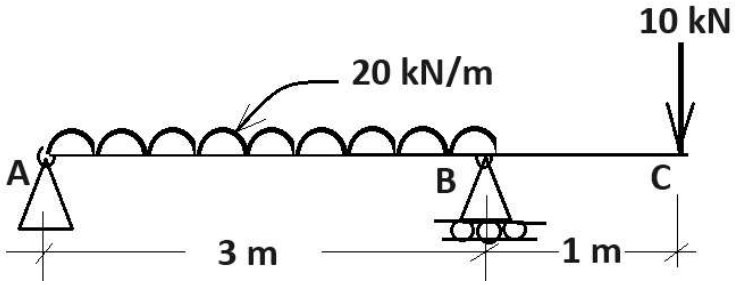
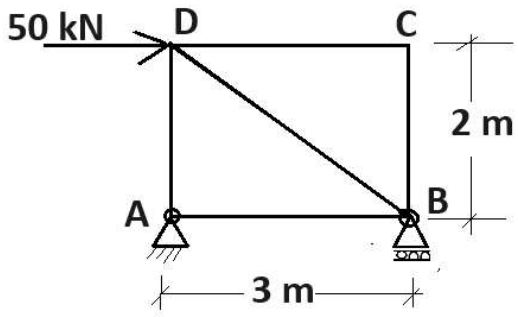
END SEMESTER EXAMINATION, DEC 2023

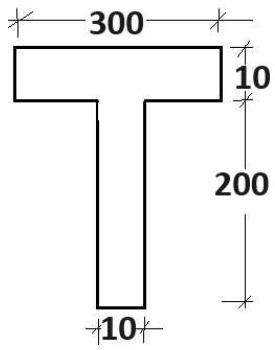
MECHANICS OF STRUCTURES (CIE 2124)

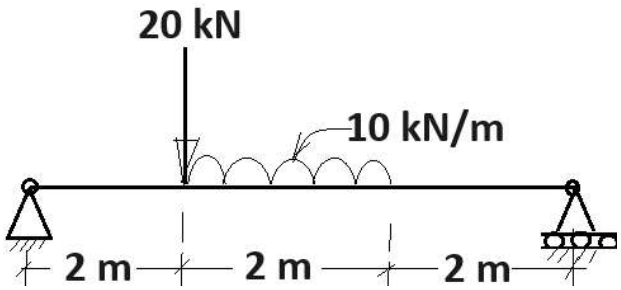
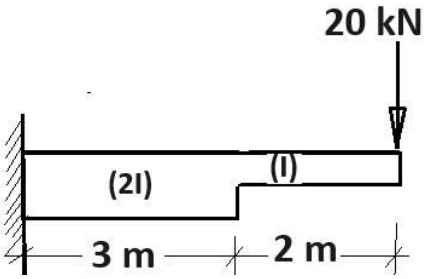
(02 – 12 - 2023)

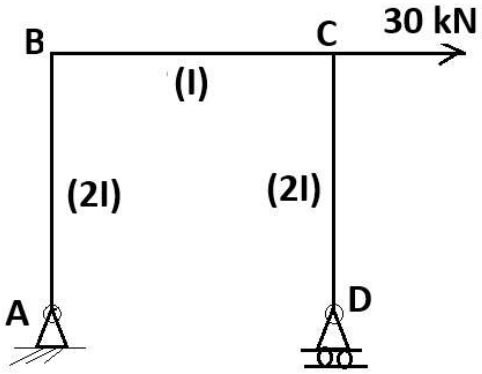
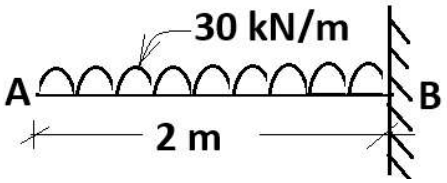
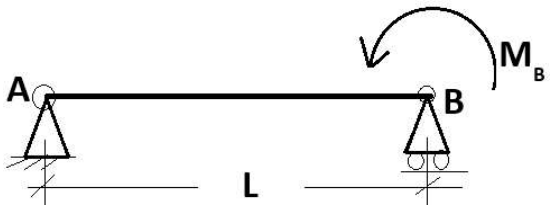
TIME: 3 HRS. **MAX. MARKS: 50**

Note: 1. Answer all questions.
2. Any missing data may be suitably assumed.
3. Use of Formula Book is permitted

Q. NO	QUESTION	MARK	CO	BL
1A	A simply supported beam with overhang at one end is loaded as shown in the below Figure. Analyse and draw the Shear Force and Bending Moment Diagrams. Locate the points of contra-flexure, if any. 	5	1	4
1B	Determine the forces in the members of the truss shown. 	3	1	3

1C	A circular bar of length 200 mm and diameter 10 mm is subjected to twisting by torque of 10 Nm. Analyse normal stress in the bar.	**2**	**2**	**4**
2A	A simply supported rectangular beam of cross-section 250 mm(wide) x 500 mm(deep) and span 5 m is loaded with a point load of 20 kN at 2 m from the right support. Determine the maximum compressive stress, tensile stress and shear stress in the beam due to bending moment and shear force (neglect the stresses due to self weight of the beam).	**5**	**2**	**3**
2B	A solid circular shaft has to transmit 100 kW of power at 200 rpm. If the allowable shear stress for the material is 50 MPa and the permissible twist is one degree in a length of 3 m, analyze required minimum diameter for the shaft. Take G = 80 GPa.	**3**	**2**	**4**
2C	A rectangular beam of cross-section 200 mm(wide) x 400 mm(deep) is simply supported over a span of 5 m. If the allowable bending stresses in the material is limited to 50 MPa, analyze maximum udl (distributed over entire span) that the beam can carry.	**2**	**2**	**4**
3A	A built-up vertical steel column of length 4 m has T cross-section as shown in the figure below (all dimensions are in mm). One end of the column is fixed and the other end is hinged. Calculate the slenderness ratio for the column. Analyze buckling load using appropriate method (Euler's Formula OR Rankine-Gordon Formula) and justify the same. Take Rankine constant as 1 / 1600, σ_c = 500 MPa, E = 200 GPa. 	**5**	**3**	**4**
3B	A cantilever beam of free length 1.5 m has built-up section with following properties: I_{NA} = 1x10^6 mm^4, Overall depth = 500 mm, Location of the neutral axis (NA) from the base = 350 mm. If the beam is loaded with a downward point load of 1kN at the free end, determine the maximum bending stresses in the beam.	**3**	**4**	**3**

3C	Derive an expression for differential equation of the elastic curve for the beam loaded with lateral loads.	**2**	**4**	**3**
4A	A simply supported beam with constant EI is loaded as shown in the below figure. Use Macauly's method of double integration and analyze deflection at mid-span. 	**5**	**4**	**4**
4B	A cantilever beam having stepped moment of inertia is loaded with a point load of 20 kN at the free end as shown in the below figure. Moment of inertia is 2I up to first 3 m length and I for the remaining 2 m length. Using moment-area theorem analyse deflection at the free end. Take I = 10 x 10^{-6} m^4 and E = 200 GPa 	**3**	**4**	**4**
4C	A solid circular bar of length 400 mm and 20 mm diameter, is subjected to a torque of 10 Nm. Determine the strain energy stored in the material. Take E = 200 GPa, G = 100 GPa.	**2**	**5**	**3**
5A	Using unit-load method, analyse horizontal displacement of the point D of portal frame, ABCD shown in the figure. The frame is loaded with 30 kN (horizontal) at C. Length of member AB and CD is 4 m each and that of	**5**	**5**	**4**

	member BC is 2 m. Moment of inertia for the member BC is I and that for AB and CD is 2I. 			
5B	A cantilever beam AB of length 2 m is loaded with an udl of 30 kN/m over entire length. Analyse slope and displacement of the free end (A) using Castigliano's strain energy theorem. Take constant EI 	**3**	**5**	**4**
5C	Using Unit-load method, determine an expression for rotation at support A due to the moment M_B applied at support B, for the simply supported beam AB and span length 'L' shown in the figure below. Take constant EI. 	**2**	**5**	**3**