Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Strength of Materials **Semester:** IV

Program: BTech (Fire and safety Engineering) **Time :** 03 hrs.

Course Code: MECH 2085 **Max. Marks:** 100

Instructions:

- Attempt all questions.
- Use neat diagrams wherever necessary.
- Assume suitable data if required.

SECTION A

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Fill in the blank: a) The unit of stress is _____. b) Torque produces _____ stress in a shaft.	 **2** **2**	CO1
Q 2	Prove that the hoop stress in thin-walled pressure vessel is exactly twice the longitudinal stress.	**4**	CO3
Q 3	Define the following: i. Factor of safety ii. Deflection	**2** **2**	CO1
Q 4	A fire truck's high-pressure hose is subjected to cyclic loading during use. Discuss: i. The stress conditions in the hose ii. How strength of materials ensures safety	 **2** **2**	CO2
Q 5	Briefly explain the significance of material selection in fire hose couplings.	**4**	CO4

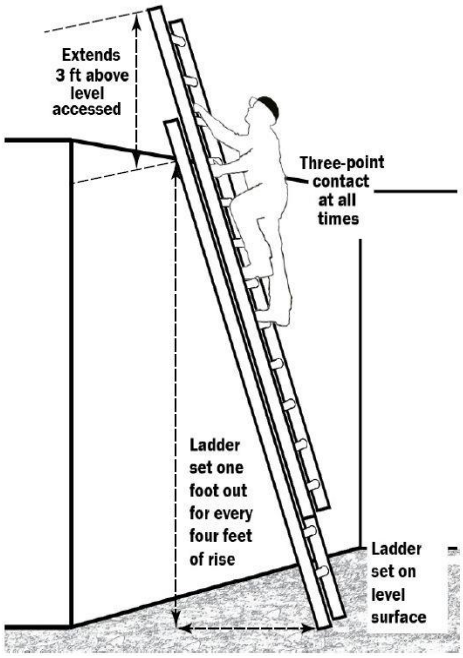
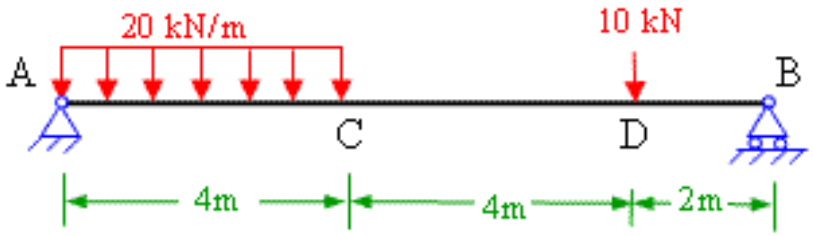
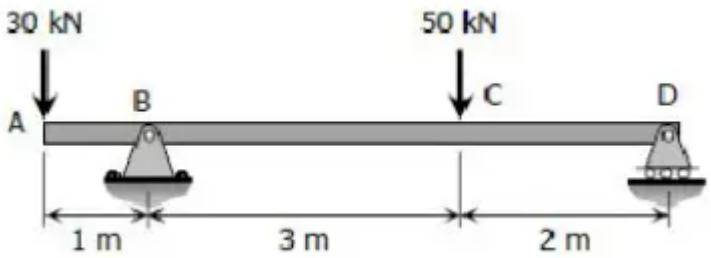
SECTION B

(4Qx10M= 40 Marks)

Attempt any four question

Q 6	A cylindrical fire extinguisher of internal radius 100 mm, wall thickness 4 mm, is subjected to internal pressure of 100 bar. Determine the hoop stress and longitudinal stress in the wall. Is the design safe if the material yield strength is 250 MPa?	**3+3+4**	CO4

Q 7	A hospital floor steel beam is subjected to fire. At 550°C, the beam is still loaded, but the modulus of elasticity drops. Calculate how much deflection increased due to heat. Given: ➢ Beam span: L=5.5 m ➢ Uniform load: w= 8.4 kN/m ➢ Moment of inertia: I=8×10−6 m4 ➢ E(room)=200 GPa ➢ E(fire)=50 GPa	**10**	**CO4**
Q 8	 Fire Extinguishers are the most commonly used safety precautionary device in the industry and households. Let us consider Clean Carbon Dioxide Gas Based Fire Extinguishers. The dimensions are: ✓ ● Capacity- 5Kg ● Height - 700 mm ● Diameter - 152 mm ● Fire Rating - 89B ✓ Pressure inside the extinguisher- 5MPa ✓ Nozzle diameter: 0.02m ✓ The lever length:10 cm. ✓ The force required to trigger the extinguisher (force at the lever end) is 40 N. i. Calculate the energy stored in the spring when it's compressed by 0.02 meters. ii. calculate the discharge force coming from the extinguisher once the pin is released.	**5** **5**	**CO 1**
Q 9	A solid steel shaft used in a **fire hose reel** is subjected to torsional force while unwinding the hose during a fire emergency. The shaft must be strong enough to withstand the applied torque without failure. **Given:** ➢ Length of the shaft (L): 0.8 m ➢ Diameter of the shaft (d): 30 mm ➢ Torque applied (T): 150 Nm ➢ Modulus of rigidity (G): 80 GPa ➢ Allowable shear stress for steel: 60 MPa Calculate: i.Maximum shear stress developed in the shaft ii.Angle of twist over the shaft length iii.Check if the shaft is safe under the applied torque	**4** **4** **2**	**C O4**

Q10	 Please refer the data for an extension ladder used in a firefighting application: **length (extended)**: 12 meters **Material**: Aluminum, with Young's Modulus E=70 GPa **Moment of Inertia (I)** for the ladder's cross-section: I=3×10−6 m4 **Applied Load (F)**: A firefighter's weight plus their equipment, totaling **1000 N**. **Distance from the base to the point of application of the load**: 6 meters. i. Calculate bending stress at the point of load application. ii. Calculate normal reaction at floor and wall.	**5+5**	**CO 1**
SECTION-C (2Qx20M=40 Marks)			
Q 11	 i. Calculate support reactions at point A and B ii. Draw shear force diagram (SFD) iii. Draw bending moments diagram (BMD) **Note:** show all the calculation steps **OR** 	**4+4 6 6**	**CO 5**

	iv. Calculate support reactions at point B and D v. Draw shear force diagram (SFD) vi. Draw bending moments diagram (BMD) **Note:** show all the calculation steps	**4+4** **6** **6**	
Q12	A steel pipe carrying water in a fire protection system of length five meters is horizontally supported at both ends.  Given: • Pipe outer diameter: 120 mm • Pipe wall thickness: 6 mm • Density of water: 1000 kg/m³ • Steel density (for pipe weight): 7850 kg/m³ Calculate: i. Weight per meter of the pipe (water + pipe) ii. Total load on the supports iii. Reactions at each support iv. Maximum bending moment	**7** **3** **3** **7**	**C O2**