Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

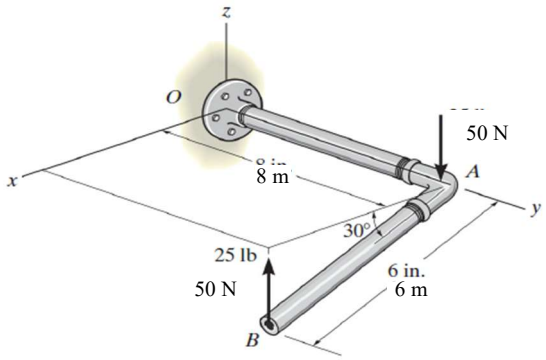
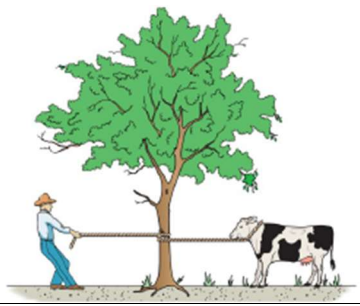
UPES

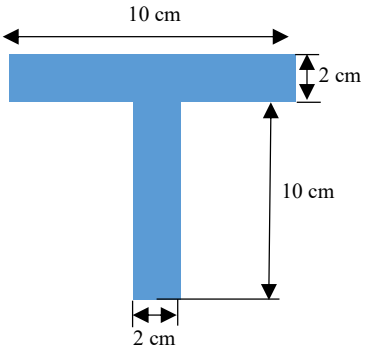
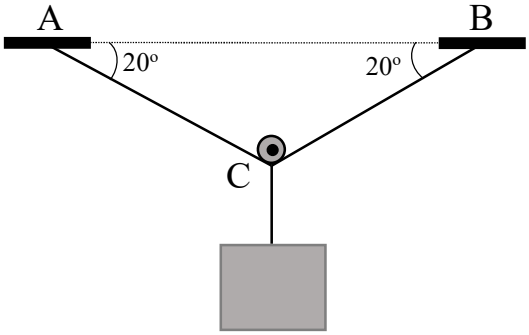
End Semester Examination, May 2025

Programme Name : B.Sc. (Hons.) Mathematics by Research **Semester : IV**
Course Name : Mechanics **Time : 03 hrs**
Course Code : MECH2074 **Max. Marks : 100**
Nos. of page(s) : 3

Instructions: *Read the questions clearly and provide needed details only.*
Draw neat and clean diagrams wherever required.

SECTION A
(5Q * 4 Marks = 20 Marks)
Answer all questions

S. No.		Marks	CO
Q1	Two forces act at a point such that their resultant is 200 N and makes an angle of 40° with the first force. The angle between the resultant and the second force is 60°. Analyze the given vector configuration and calculate the magnitudes of the two forces involved.	4	CO1
Q2	Determine the couple moment acting on the pipe shown in figure. 	4	CO1
Q3	A 180-lb farmer attempts to restrain a cow from escaping by wrapping a rope two times around a tree trunk. The cow pulls on the rope with a force of 250 lb. Analyze the scenario and determine the minimum force the farmer must apply to hold the cow successfully. Given the coefficient of static friction between the rope and the tree is $\mu_s = 0.15$. 	4	CO2

Q4	Explain the concept of uniformly accelerated motion. Using appropriate graphs, illustrate how acceleration, velocity, and position change over time for an object undergoing uniformly accelerated motion.	**4**	**CO3**
Q5	Show that for a moving body with varying mass, the force on the system is given as, $\frac{d}{dt}(mv) = F + u\frac{dm}{dt}$.	**4**	**CO4**
	SECTION B **(4Q * 10 Marks = 40 Marks)** **Q6, Q7 & Q8 are compulsory; there is an internal choice for Q9**		
Q6	Determine the moment of inertia of a semicircular area of radius R about its centroidal axes.	**10**	**CO2**
Q7	Determine the moment of inertia of area the T-section shown in figure about the centroidal axes. 	**10**	**CO2**
Q8	A particle is under rectilinear motion along positive x-axis. The acceleration of the particle varies as $\alpha \propto -v$, where v is in ms^{-1}. Determine the equation of motion for the particle if $x(0) = 0$ and $v(0) = v_o$.	**10**	**CO3**
Q9	A body of 100 kg mass is hanging from a rope attached to two fixed points A and B, as shown in figure. Determine the tensions in the ropes AC and AB. The weight of the rope can be neglected. 	**10**	**CO1**

	OR A force of 200 N is acting along the points A (1, 2, 3) and B (5, 6, 2) with distance in meters. Determine the moment of force about the origin.	**10**	
	SECTION C **(2Q * 20 Marks = 40 Marks)** **Q10 is compulsory; there is an internal choice for Q11**		
Q10	A particle is under rectilinear motion where its position is given by $x = t^3 - 8t^2 + 16t - 5$ meters and t is expressed in seconds. a) Determine the instant(s) at which velocity of the particle is zero. b) Find the position and instantaneous acceleration at that time. c) Determine the instant at which acceleration of the particle is zero. d) Determine the position, displacement, and total distance covered by the particle for this instant.	**5** **5** **5** **5**	**CO3**
Q11	A spherical raindrop, falling freely, receives in each instant an increase of volume equal to λ times its surface at that instant. Find the velocity at the end of time t, and the distance fallen through in that time. OR Using the principle of conservation of momentum, derive the equation governing the motion of a rocket (the rocket equation). Apply this equation to calculate the change in velocity of a rocket in deep space that ejects fuel at a constant relative speed of 1000 ms^{-1}, starting with an initial mass of 1000 kg and ending with a final mass of 500 kg. Assume the rocket is initially at rest and that no external forces act on it.	**20** **20**	**CO4**