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

UPES

End Semester Examination, May 2025

Course: Foundational Mechanics — **Semester: II**

Program: B.Sc. Math + Geo — **Time: 03 hrs.**

Course Code: MECH1003 — **Max. Marks: 100**

Instructions: Read the instructions carefully and follow them strictly.

i) **Mention roll no. at the top of the question paper.**

ii) **Attempt all the parts of a question at one place only.**

SECTION A (Attempt all the questions)

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Explain the radius of gyration. What is its unit?	**4**	**CO1**
Q 2	Explain Lorentz Fitzgerald contraction. Find out the necessary expressions.	**4**	**CO2**
Q 3	What are the negative results of Michelson Morley Experiment? Discuss their importance.	**4**	**CO2**
Q 4	Explain Young's modulus and bulk modulus.	**4**	**CO3**
Q 5	Calculate the fractional change in the mass of the hydrogen atom when it is ionized from the following data; The binding energy of the hydrogen atom = 13.85 eV. The rest mass of the hydrogen atom = 1.00797 a.m.u	**4**	**CO4**

SECTION B (Attempt all the questions. Question 9 has an internal choice)

(4Qx10M= 40 Marks)

Q 6	Relate the kinetic energy, potential energy, total energy and angular momentum **J** of a satellite of mass **m** moving in a circular orbit of radius **r.**	**10**	**CO1**
Q 7	Describe the moment of inertia of a rectangular lamina about an axis perpendicular to its plane and passing through its center of mass.	**10**	**CO1**
Q 8	Sketch Kepler's law of planetary motion. If r is the radius vector joining a particle of mass m with the center of force and A is the area swept out by the radius vector, show that; $dA = \frac{1}{2} r \times dr$ and $\frac{dA}{dt} = \frac{j}{2m}$ Where, j is the angular momentum of the particle.	**10**	**CO3**
Q 9	Explain with a proper reason that a hollow cylinder is stronger and hence a better shaft than a solid one of the same mass, length and material.		

	Or Deduce the following relation for an elastic medium. $$\eta = \frac{Y}{2(1+\sigma)}$$	**10**	**CO4**
SECTION-C (Attempt all the questions. Question 11 has internal choice) **(2Qx20M=40 Marks)**			
Q 10	(a) Deduce an expression for the gravitational potential at the surface of spherical shell. (b) Explain the working of a multi-stage rocket. Discuss its motion when the rocket is moving in a free space field with no frictional forces and when it is moving in a region where gravitational forces are present.	**10** **10**	**CO2**
Q 11	(a) Obtain a relativistic formula for the addition of velocities. Hence show that the velocity of light is an absolute constant independent of the frame of reference and that it is the maximum velocity attainable in nature. (b) Calculate the orbital velocity of sun about the center of galaxy. (Given mass of galaxy = $4\ X\ 10^{41}\ kg$ and radius of galaxy = $10^{21}\ meter$) **Or** (a) A body moving with velocity v has a mass m. Show that $$m = \frac{m_0}{\sqrt{(1-\frac{v^2}{c^2})}}$$ where, m_0 is the rest mass of the body and c is the speed of light. (b The rest mass of an electron is $9.1\ X\ 10^{-28}\ g$. What will be its mass if it were moving with $\frac{4}{5}\ th$ the speed of light	**15** **5** **15** **5**	**CO3** **CO4** **CO3** **CO4**