


Name:			
Enrolment No:			
UPES End Semester Examination, May 2024			
Course: Foundational Mechanics Program: B.Sc. Math + Geo Course Code: MECH1003		Semester: II Time: 03 hrs. 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	Show that the time rate of change of angular momentum of a particle is equal to torque acting on it.	4	CO1
Q 2	Summarize the negative results of Michelson Morley Experiments. Discuss their importance.	4	CO2
Q 3	Interpret the reduced mass. Explain its physical significance.	4	CO2
Q 4	Explain Young's modulus and bulk modulus.	4	CO3
Q 5	A solid sphere of mass 1.0 kg and diameter 10 cm rolls without sliding with a uniform velocity of 50 cm/sec along a straight line on a smooth horizontal table. Calculate its total energy.	4	CO4
SECTION B (Attempt all the questions. Question 9 has an internal choice) (4Qx10M= 40 Marks)			
Q 6	Relate the kinetic, potential, 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. Show that the time-period of revolution of the planet in an elliptical orbit is; $T = \sqrt{\frac{4\pi^2 m^2 l a^3}{J^2}}$ Where <i>a</i> is the semi-major axis and <i>l</i> is the semi-latus rectum of the ellipse.	10	CO3

Q 9	<p>Find the greatest length of a wire that can be suspended without breaking. Its breaking stress and density equal $7.2 \times 10^8 \text{ N/m}^2$ and $7.8 \times 10^3 \text{ N/m}^3$, respectively.</p> <p style="text-align: center;">Or</p> <p>Deduce the relation between Young's modulus Y, Bulk modulus K, and Poisson's ratio σ;</p> $K = \frac{Y}{3(1 - 2\sigma)}$	10	CO4
<p>SECTION-C (Attempt all the questions. Question 11 has internal choice) (2Qx20M=40 Marks)</p>			
Q 10	<p>(a) Deduce an expression for the gravitational field and potential at a point outside a thin uniform spherical shell.</p> <p>(b) Explain the 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.</p>	<p>10</p> <p>10</p>	CO2
Q 11	<p>(a) A body moving with velocity v has a mass m. Show that</p> $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$ <p>Where m_0 is the rest mass of the body and c is the speed of light.</p> <p>(b) Derive the relation between energy and momentum; $E^2 = p^2 c^2 + m_0^2 c^4$</p> <p style="text-align: center;">Or</p> <p>(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.</p> <p>(b) A beam of particles of half-life 2×10^{-6} sec travels in the laboratory at speed 0.96 times the speed of light. How much distance does the beam travel before the flux fall to $\frac{1}{2}$ times the initial flux?</p>	<p>15</p> <p>5</p>	<p>CO3</p> <p>CO4</p>