CLASS: I.M.Sc.   SEMESTER : I
BRANCH: PHYSICS   SESSION : MO/2022

SUBJECT: PH101 - MECHANICS

TIME: 3 Hours   FULL MARKS: 50

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	A rocket is an example of a variable mass system. Develop the equation of rocket motion in free space.	[5]	1	III
Q.1(b)	Potential energy of a one-dimensional system is given by $U(x) = x^2 + 10 \exp(-x^2)$. Sketch the energy diagram of the system. Find and identify the stable & unstable equilibrium points of the system	[5]	1	I, III
Q.2(a)	Define centre of mass frame. Explain the two particle elastic collision process in laboratory frame and in centre of mass frame.	[5]	2	II
Q.2(b)	A thick hollow cylinder of mass $M = 0.3\,\text{kg}$, inner radius $R_1 = 1\,\text{cm}$ and outer radius $R_1 = 2\,\text{cm}$ starts rolling (without slipping) down a plane inclined at $30°$. Find the velocity of cylinder at a distance of 1 m from the starting point.	[5]	2	III
Q.3(a)	Show that two-body central force problem can be reduced to one-body problem.	[5]	3	II
Q.3(b)	Solve the equation of motion of a damped harmonic oscillator. State the criteria for motion to be under damped, over damped or critically damped.	[5]	3	II, V
Q.4(a)	Starting from general rule that relates time derivatives of a vector in inertial frame and rotating frame, develop the expression for velocity and acceleration in a rotating frame.	[5]	4	I, VI
Q.4(b)	Instantaneous position of a particle is given as $\vec{\mathbf{r}} = 4\cos(8\pi t)\,\hat{\mathbf{i}} + 4\sin(8\pi t)\,\hat{\mathbf{j}} + 3\hat{\mathbf{k}}.$ Determine the position and velocity of the particle in cylindrical coordinate system.	[5]	4	V
Q.5(a)	Starting from Lorentz transformation equations, develop the formulae for relativistic addition of velocities.	[5]	5	III
Q.5(b)	Muons are created in upper atmosphere due to cosmic rays and are detected at ground based laboratories although mean life-time of muons in only 2.2 microseconds. Resolve the paradox by analyzing the problem from laboratory frame of reference and muons' frame of reference.	[5]	5	IV

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