BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION MO/2022)

CLASS: IMSc. **SEMESTER : I**
BRANCH: PHYSICS **SESSION : MO/2022**

SUBJECT: PH101 - MECHANICS

TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1(a)	Define inertial frames and write Galilean transformation equations.	[2]	1	1
Q.1(b)	Consider two inertial frames S and S' having a constant relative velocity v. Can *speed* of a particle be same in both the frames, explain.	[3]	1	2
Q.2(a)	Four point masses, $m_1 = 1\ \text{g},\ m_2 = 2\ \text{g},\ m_3 = 3\ \text{g},\ \text{and}\ m_4 = 4\ \text{g}$, are placed at the corners of a square of length $5\ \text{cm}$. Find the distance of centre of mass from the mass m_4.	[2]	1	3
Q.2(b)	A spaceship of mass $m = 1100\ \text{kg}$ moves with constant velocity $v = 2.5\ \text{km/s}$ in a region where gravitational effects are negligible. A thruster that expels $0.5\ \text{kg}$ mass per second with a velocity of $100\ \text{km/s}$ is fired for a duration of 5 minutes to increase its velocity. Determine the final velocity of the spaceship.	[3]	1	5
Q.3(a)	Explain work-energy theorem and define conservative force.	[2]	1	2
Q.3(b)	Two particles, $m_1 = 10\ \text{g}\ \text{and}\ m_2 = 6\ \text{g}$ are moving with velocities $v_1 = 3\hat{\imath} + 4\hat{\jmath}\ \text{and}\ v_2 = 4\hat{\imath} - 3\hat{\jmath}$, respectively (in laboratory frame). Find the velocity of the centre of mass and compare total kinetic energies of the particles in centre of mass frame and in laboratory frame.	[3]	2	1,4
Q.4(a)	A particle of mass m moving with velocity v undergoes an elastic collision with a particle of mass $5m$ initially at rest. The scattering angle in laboratory frame is observed to be $30°$. Find the scattering angle in centre of mass frame.	[2]	2	1
Q.4(b)	A sphere of mass M and radius R starts rolling down a slope without slipping. Develop the expression for its velocity as a function of vertical distance covered.	[3]	2	3
Q.5(a)	What is the relation among Young's modulus, bulk modulus and modulus of rigidity of an elastic material.	[2]	2	1
Q.5(b)	Young's modulus and Poisson ratio of steel are $1.9 \times 10^{11}\ N/m^2$ and 0.3, respectively. Determine its modulus of rigidity.	[3]	2	5

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