7/12/19 M

Roll No. ☐☐☐☐☐☐☐☐☐☐☐

S. No. of Question Paper : **8573**

Unique Paper Code : **42221101**　　　　　　　J

Name of the Paper : **Mechanics**

Name of the Course : **B.Sc. (Prog.)**

Semester : **I**

Duration : **3 Hours**　　　　　　　Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

1.　(*a*)　For the vectors A = $3i - 2j + k$ and B = $2i - k$, determine

　　　　A · B and (A × B) · A.　　　　　　5

　(*b*)　Prove (A × B) × C = (A · C) B − (B · C) · A.　　5

　(*c*)　Solve the differential equation

　　　　$$(x^2 - y^2)\, dy - 2xy\, dx = 0.$$　　　　5

2.　(*a*)　State Kepler's laws of planetary motion.　　3

(b) What is a central force ? Give examples of central forces. Prove that under the influence of a central force, the motion of a particle is always confined to a plane.   7

(c) A satellite revolves around a planet of mean density 10^4 kg/m^3. If the radius of its orbit is only slightly greater than the radius of the planet, find the time of revolution of the satellite.

[G = 6.67×10^{-11} S.I. units]   5

3. (a) What do you understand by the centre of mass of a system of particles ? Show that in the absence of external forces the velocity of the centre of mass remains constant. 5

(b) What is moment of inertia ? State parallel and perpendicular axis theorems.   5

(c) The angular momentum of a rotating body is conserved, while its moment of inertia is decreased. Show that its rotational kinetic energy increases.   5

4. (a) State and prove work-energy theorem.   5

(b) What are conservative and non-conservative forces ? Show that work done by a conservative force along a closed path is zero.   5

(c) Establish the equation of motion of a rocket and obtain the velocity of the rocket at time t taking into account the effect of gravity.   5

5. (a) Define kinetic energy of rotation. Develop an expression for kinetic energy involving both translation and rotation.   10

(b) A torque of 1 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting translational acceleration ?   5

6. (a) What do you understand by simple harmonic motion ? Set up the differential equation of motion for a simple harmonic motion and obtain its solution. Find the expression for time period and angular frequency.   10

(b)   At what displacement the kinetic and potential energies
are equal ?   5

7.   (a)   Differentiate between inertial and non-inertial frames.   2

(b)   State Einstein's postulates of special theory of relativity.
Derive the Lorentz transformation equations.   8

(c)   A rod 1m long is moving along its length with a velocity
0.6c. Calculate its length as it appears to an observer on
the earth.   5