



DCX-003-1161006

Seat No. _____

M. Sc. (Sem. I) Examination

August - 2022

Mathematics : EMT-1001

(Classical Mechanics - I)

Faculty Code : 003

Subject Code : 1161006

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

- Instructions :** (1) Attempt any five questions, from the following.
(2) There are total ten questions.
(3) Each question carries equal marks.

1 Attempt the following : **14**

- (1) Define : Linear momentum.
- (2) Define : Torque or moment of force.
- (3) Define with example : Non-Holonomic constraints.
- (4) Define with example : Scleronomuous constraints.
- (5) When a system is said to be a conservative?
- (6) Define with example : Degrees of freedom.
- (7) Define : Configuration space.

2 Attempt the following : **14**

- (1) Define : Monogenic system.
- (2) State only the Hamilton's variational principle.
- (3) State only the Kepler's first law of planetary motion.
- (4) Find the degrees of freedom for dumbbell and fixed fulcrum of a simple pendulum.
- (5) Define : Angular momentum.
- (6) State the problems arising due to constraints.
- (7) What is central force?

- 3** Attempt the following : **14**
- (a) State and prove linear momentum conservation theorem for a system of particles.
- (b) Discuss in detail the problem of Atwood machine.
- 4** Attempt the following : **14**
- (a) Discuss in detail the conservation of total energy for a system of particles.
- (b) Derive the Lagrange's equations of motion for conservative Holonomic system.
- 5** Attempt the following : **14**
- (a) Derive the Lagrange's equations of motion for a single particle in space with mass m in
- (i) Cartesian co-ordinates
- (ii) Plane polar co-ordinates
- (b) Show that the shortest distance between two points in a plane is a straight line.
- 6** Attempt the following : **14**
- (a) Find the minimum surface of revolution about y -axis.
- (b) A particle falls a distance y_0 in a time $t_0 = \sqrt{2y_0/g}$.
- If the distance $y = at + bt^2$ then show that the integral
- $$\int_0^{t_0} L dt$$
- has an extremum for real values of coefficients
- only when $a=0$ and $b = \frac{g}{2}$.
- 7** Attempt the following : **14**
- (a) A hoop rolling without slipping down an inclined plane then find the force of friction acting on the hoop.
- (b) Derive the equations of motion and find the first integrals for two bodies central force motion.

- 8** Attempt the following : **14**
- (a) Discuss in detail the use of direction cosines to describe the independent co-ordinates relative to the rigid body motion.
 - (b) Define cyclic co-ordinate and show that if V being independent of velocities and L is not an explicit function of time then total energy is conserved.
- 9** Attempt the following : **14**
- (a) Define Euler angles and obtain the transformation matrix A from space axes to body axes. Also derive A^{-1} .
 - (b) Derive the orthogonal matrix of transformation in 2-dimensional co-ordinate system.
- 10** Attempt the following : **14**
- (a) Derive the orthogonal transformation in terms of Cayley-Klein parameters.
 - (b) Derive the Kepler's third law of planetary motion.
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