647510 **MSC1MatE101x** **Seat No :_____**

M.Sc.(Maths.) Semester - 1 (*CBCS*) Examination
Nov/Dec - 2022 [NEW COURSE]
Classical Mechanics 1(Elective (New))

Time: 2:30 Hours **Marks: 70**

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate marks.

Q.1(A): Answer any one of following question. **(04)**

(i) State and prove law of conservation of linear momentum for a particle.

(ii) Prove that total virtual work done on a system of particle in equilibrium vanishes.

Q.1(B): Attempt any two out of three. **(10)**

(i) Prove that Newton's equations of motion and Lagrange's equations of motion are same in absence of constraints.

(ii) Define principle of virtual work and derive D'Alembert's principle.

(iii) State Lagrange's equations of motion in general case and derive it for non-conservative force.

Q.2(A): Answer any one of following question. **(04)**

(i) Define Hamiltonian's principle and derive Lagrange's equations of motion from it.

(ii) Describe Brachistochrone problem (Problem of least time).

Q.2(B): Attempt any two out of three. **(10)**

(i) In usual notations derive condition for extremum.

(ii) State law of conservation of energy in Lagrangian formalism and using it show that energy is conserved for Simple Harmonic Oscillator.

(iii) Obtain the curve for minimum surface of revolution.

Q.3(A): Answer any one of following question. **(04)**

(i) State and prove Euler's theorem on motion of rigid body.

(ii) Lagrangian of Simple Harmonic Oscillator is given by $L = \frac{m}{2}\dot{x}^2 - \frac{k}{2}x^2$. Obtain its Hamiltonian.

Q.3(B): Attempt any two out of three. **(10)**

(i) Show that the central force motion of two bodies about their centre of mass can always be reduced to an equivalent one body problem.

(ii) State and prove Kepler's third law of planetary motion.

(iii) If a particle of mass m moves under a central force then its orbit is a plane curve.

Q.4(A): Answer any one of following question. **(04)**

(i) Write any one effect of Coriolis force.

(ii) Prove that the matrix for infinitesimal canonical transformation is symplectic.

Q.4(B): Attempt any two out of three. **(10)**

(i) Derive Cayley-Klein parameters.

(ii) Discuss in detail finite rotation.

(iii) In usual notations derive the formula $dr = r \times d\Omega$

Q.5(A): Answer any one of following question. **(04)**

(i) Derive energy function.

(ii) Define canonical transformation. Is the following transformation canonical? $Q_1 = q_1$, $P_1 = p_1 - 2p_2$, $Q_2 = p_2$, $P_2 = -2q_1 - q_2$

Q.5(B): Attempt any two out of three. **(10)**

(i) Giving all details about Atwood's machine, derive Lagrange's equations of motion for it.

(ii) State and prove Euler's theorem in motion of rigid body.

(iii) Explain Eulerian angles.

****