MANIPAL UNIVERSITY

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DEPARTMENT OF SCIENCES

FIRST SEMESTER M.SC(PHYSICS) END SEMESTER EXAMINATION, NOVEMBER 2017

SUB: CLASSICAL MECHANICS (PHY- 4103) (REVISED CREDIT SYSTEM-2017)

TIME: 3 HRS. DATE: 19-12-2017 MAX. MARKS : 50

NOTE: ANSWER ALL FIVE FULL QUESTIONS.

1A A projectile motion in a resistive medium is described by $x = \frac{U}{k}\left(1 - e^{-kt}\right)$ and $y = -\frac{gt}{k} + \frac{kV+g}{k^2}\left(1 - e^{-kt}\right)$, where $x = U, y = V$ when $t = 0$, $k =$ resistive force per unit velocity per unit mass. Obtain an expression for its range of flight when the air resistance is small. Given the expression for the time of flight: $T \cong \frac{2V}{g}\left(1 - \frac{kV}{3g}\right)$. Also obtain an expression for the difference in the range of flight of the projectile in the medium with and without resistance. [4]

1B Obtain an expression for the kinetic energy of a system of particles as a sum of the kinetic energy of a particle (with the mass equal to the total mass of the system) at the centre of mass and moving with velocity $\vec{V}$ with respect to the origin and the kinetic energy of the system referred to centre of mass as the origin. [4]

1C Show that the work done on a particle by external force is equal to the increase in kinetic energy. [2]

2A Obtain Lagrangian for a spherical pendulum and hence obtain the equations of motion. [5]

2B Write a short note on constraints giving illustrations. [3]

2C Given the force $\vec{F} = \hat{\imath}(xy) - \hat{\jmath}(y^2)$, [all quantities in SI-units] find the work done in moving a particle from (0, 0) to (2, 1). [2]

3A Show that the plane of oscillation of Focault pendulum at latitude θ rotates through $2\pi \sin\theta$ everyday. [5]

3B Obtain an expression for the rotational kinetic energy of a rigid body, in terms of inertia elements. [3]

3C Distinguish between a symmetric top, a spherical top and a rotor. [2]

4A Obtain the solution of the one-dimensional harmonic oscillator by Hamilton-Jacobi method. [Obtain the Hamilton-Jacobi equation for a one-dimensional harmonic oscillator and hence obtain its solution.] [5]

4B Prove the relation using the properties of the poisson brackets (x, y, z are cyclic): $[L^2, L_x] = 0$. [3]

4C Obtain the transformations generated by the function $\sum_k p_k Q_k$. [2]

5A Obtain the stress tensor elements and the strain tensor elements in terms of free energy and Gibbs function. [6]

5B Discuss the oscillations in 2 coupled simple pendulums: Obtain the expressions for coordinates of the pendulum. [4]

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