Tribhuwan University
Institute of Science and Technology
2067

Bachelor Level / First Semester / Science — Full marks: 60
Computer Science and Information Technology(PHY113) — Pass marks: 24
((TU CSIT) Physics) — Time: 3 hours
Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.

Set A

Attempt all questions:

1. A reference frame rotates with respect to another inertial reference frame with uniform angular velocity w. The position, velocity and acceleration of a particle in the inertial frame of reference is $\vec{r}$ $\vec{v}$ and $\vec{a}$. Find the acceleration of the particle in the rotating frame of reference.

2. Consider a system with potential energy $U(\vec{r})$

a. Show that force acting on the system is given by $\vec{F}(\vec{r}) = -\nabla U(\vec{r})$.

b. For the system above it is given that $U(\vec{r})$ is translationally invariant i.e, $U(\vec{r}+\vec{a}) = U(\vec{r})$.

Show that linear momentum of the system is conserved. (3.5 +3.5)

3. a) State the assumptions made in deducing Stoke's law for the motion of a small sphere in a viscous medium. Use dimensional arguments to derive Stoke's law. (3.5)

b) Define dipole moment and derive expression for electric field of a dipole. (3.5)

4. Discuss and derive the boundary conditions imposed on the field vectors $\vec{H}$ and $\vec{B}$ and at the interface of two dielectric media. (7)

5. Use Maxwell's equations to derive wave equation for electric and magnetic field. (7)

Set B

Attempt any eight questions:

6. The initial position of a particle of mass 100g is $\vec{r} = 2\hat{i} + 2\hat{k}$ and its initial velocity is $\vec{u} = 2\hat{i} + 0.1\hat{k}$ ms^{-1} . A force $\vec{F} = 1\,\hat{i} + 0.75\hat{j}$ N acts upon the particle for 5 sec. Obtain the final velocity and final position.

7. An electron describes a helix of radius 0.2 m and pitch 0.03 cm in a magnetic field of 50 gauss(104 gauss = 1 Tesla). Calculate the components of its velocity alloy and
Perpendicular to the field. (4)

8. A satellite of m is revolving around the earth in a circular orbit of radius r = R + h, where R is the radius of the earth and h is the height of the satellite above earth's surface. Calculate the angular momentum of the satellite about the center of the earth. (4)

9. An LC circuit oscillates with a frequency of 200 Hz. The capacitance in the circuit is 10 μF. What is the value of the inductance? (4)

10.Two horizontal capillary tubes A and B are connected together in series so that a steady stream of liquid flows through them. A is 0.4 mm in internal radius and 250 cm long while B is 0.3 mm in internal radius and 40 cm long. The pressure of the fluid is 7.5 cm of Hg above the atmospheric pressure at the entrance point of A. At the exit point of B the pressure is atmospheric (76 cm of Hg). What is the pressure at the junction of A and B? (4)

11. The screened coulomb potential $V = \frac{f}{r} e^{\frac{r}{a}}$ **is very common in a conducting medium. Calculate the corresponding electric field and charge density. (4)**

12. A plane slab of material with dielectric constant K has air on both sides. The electric field in air is E_0 and it is uniform and perpendicular to the boundaries. Find the field inside the dielectric. (4)

13. Two identical air capacitors are connected in series and the combination is maintained at a constant voltage 50v. A dielectric sheet of dielectric constant 6 and thickness equal to the sixth of the air gap is now inserted into one of the capacitors. What is the voltage across that capacitor? (4)

14. Show that magnetic field energy of a system of currents is given by $U = \frac{1}{2} \int \mu \vec{I} \cdot \vec{A} \, dv$ **where** $\vec{I}$ **is current density,** $\vec{A}$ **is vector potential and dv is the volume element. The**

integration is carried over volume. (4)

15. A capacitor C, a resistor R and a battery of voltage V_0 are connected in series with a switch. The switch is closed at time t =0. Set up the differential equation for charge of on the capacitor and determine it as a function of time.