Seat No. : _____

11C-130

May-2015

M.Sc., Sem.-II

408 : Physics

(Classical Mechanics-II, Electrodynamics & Plasma Physics)

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) Attempt **all** questions.

(2) **All** questions carry equal marks.

(3) Symbols have their usual meaning.

(4) Scientific calculator is allowed.

1. (a) Write general form of 2^{nd} order linear differential equation. Explain in detail how phase trajectory can be obtained. What do you mean by singular and ordinary points ? In case of 2^{nd} order linear differential equation of the type $\ddot{x} + bx^3 = 0$, obtain necessary equation showing that periodic time explicitly depends on energy. **7**

OR

Show that the phase trajectories of the system whose equations of motion is $\ddot{x} - \sigma^2 x = 0$ are hyperbolic curve with $y = \pm\sigma x$ as asymptotes. Also obtain parametric equations.

(b) Discuss limit cycles and attractors. What do you mean stable and unstable limit cycles. **7**

OR

Show that the oscillations of a simple pendulum are non-linear with period. $T = \frac{4}{\omega_0} k \left(\sin \frac{\theta_0}{2} \right)$, where k sin $\theta_0/2$ is elliptical integral and θ_0 the angular displacement. Show that for relatively small amplitude $T = T_0 \left(1 + \frac{\theta_0^2}{16} \right)$, where $T_0 = \frac{2\pi}{\omega_0}$.

2. (a) Write transformation equations for the components of electric field $\bar{E}$ and E as well as magnetic field $\bar{B}$ and B. Using such relations show that **7**

(1) $\bar{E}.\bar{B} = E.B$

(2) $\bar{E}^2 - C^2\bar{B}^2 = E^2 - C^2 B^2$

OR

Write Lorentz transformation equations. Show that $(\bar{x})^\mu = \sum_{\nu=0}^{3} \left[\Lambda_\nu^\mu \right] x^\nu$. What do you mean by proper velocity ? Also write transformation equation for proper velocity and explain proper acceleration. Find zeroth component of proper acceleration.

(b) Find out the acceleration of charge particle moving in the electromagnetic field. **7**

OR

Write equation of the electric field of charge 'q' moving with uniform velocity 'v'. Show that such electric field integral over total area of the sphere [radius R] Gauss law is obeyed.

3. (a) Discuss radiation damping phenomenon and obtain the expression of Abraham-Lorentz equation. Also using above equation, derive the relation $l = \tau\omega^2$. **7**

OR

Show that two particles having charges e_1, e_2 and masses m_1, m_2 respectively, are approaching towards each other, then find out dipole moment "P" of the system is given by $P = \mu\left[\frac{e_1}{m_1} - \frac{e_2}{m_2}\right]\vec{r}$ where $\vec{r}$ = initial distance between two charge particles and μ = reduced mass. Also show that is particles are identical then dipole radiation is zero.

(b) Derive the Rayleigh's scattering expression for the bound charge particle. **7**

OR

Obtain the dispersion relation for dilute gases

$$\eta^2 = 1 + \sum_{\alpha} \frac{Nf_\alpha e^2}{m_\alpha \varepsilon_0}\left[\frac{1}{(\omega_\alpha{}^2 - \omega^2) - il_\alpha\omega}\right]$$

4. (a) Derive Boltzmann-Vlasov equation with and without collision term. **7**

OR

Write the B-V equation and obtain 1st and 2nd moment equations and write your comment on moment equations.

(b) (1) For a fully ionized plasma, conductivity is almost infinity, then show that velocity is perpendicular to $\vec{E}$ and $\vec{B}$ both. **3**

(2) Show that polarization current densitiy $\vec{J}_P = n_0 \frac{(m_i + m_e)}{B^2}\vec{E}$ **4**

OR

Obtain Liouville equation for the distribution of 'N' particles in 6-D space

$$\frac{\partial f^{(N)}}{\partial t} + \sum_{\alpha=1}^{N} (V_\alpha . \vec{\nabla}_{r\alpha} f^{(N)} + \vec{\alpha}_\alpha . \vec{\nabla}_{v\alpha} f^{(N)} = 0$$

5. Write short answers : **14**

(1) What will be angular velocity of the simple pendulum at extreme points ?

(2) What is saddle point ?

(3) 'Lorentz transformation matrix is a symmetric matrix.' (True / False)

(4) What will be the dimension of the factor 'β' in the Lorentz transformation equation ?

(5) What is focal point ?

(6) What do you mean by separative ?

(7) If $b^2 > \omega_0^2$, the motion is overdamped or undamped.

(8) State the relation between energy (eV) and temperature (°K).

(9) Define Magneto-hydrodynamics.

(10) In case of Rayleigh scattering, what is the scattering cross-section value if $\omega <<< \omega_0$ and $\omega_1 <<< w_0^2$?

(11) State the relation between dipole moment and di-electric susceptibility.

(12) Define skin depth.

(13) At what temperature °C and °F are at same scale ?

(14) When collision is predominates equation and collision is negligible then equation is applicable.
