Seat No. : _______________

AR-126

May-2016

M.Sc., Sem.-II

408 : Physics
(Classical Mechanics – II, Electrodynamics and Plasma Physics)

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

Instructions : (1) Attempt **all** questions.
(2) Symbols and terminology used have their usual meaning.
(3) Figures to the right indicate full marks.

1. (a) Write 2^{nd} order differential equations for the damped SHO. Explain in detail how this equations can be solved to discuss phase trajectories for under damped and over damped motions. What will be phase trajectory of particle with $b^2 = \omega_0^2$? **7**

OR

Discuss phase trajectories of a non linear conservative system by considering the motion of mass 'm' attracted towards a fixed point by a non linear restoring force $F(x)$. If $F(x) = x^2 + ax$, then with the help of the phase trajectories explain what do you mean by separatix.

(b) Show that the oscillations of a simple pendulum are non-linear with time 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 is angular displacement. Show that for small amplitude $T = T_0 \left(1 + \frac{\theta_0^2}{16}\right)$, where $T_0 = 2\pi/\omega_0$. **7**

OR

(1) Show that phase trajectory in case of SHO with having mass 'm' and force constant 'k' is ellipse, furthermore, a phase trajectory is circle if we draw graph of $\frac{y}{\omega_0} \rightarrow x$. **4**

(2) Show that phase trajectories of the system whose equation of motion is $\ddot{x} - \sigma^2 x = 0$ are hyperbolic curves with $y = \pm\sigma x$ as asymptotes. **3**

2. (a) Explain : Transition from discrete to continuous system for a infinitely long elastic rod which can undergo small longitudinal vibrations. Find Lagrangian density. **7**

OR

Write transformation equation for the components of electric field and magnetic field. Also show that $\bar{E}.\bar{B}$ and $E^2 - C^2B^2$ are relativistically invariant. **7**

(b) (1) Write Lorentz transformation equations. show that $\bar{x}^{\nu} = \sum_{\nu=0}^{3} (\Lambda^{\mu}_{\nu})x^{\mu}$. **3**

(2) Explain proper velocity. Define proper acceleration and find out proper acceleration α° and α in terms of ordinary velocity $\vec{v}$ and ordinary acceleration $\vec{a}$. **4**

OR

Discuss the motion of particle under the constant force and show that the graph of position against time is parabola classically, but it is hyperbola when we consider relativistic motion of particle. **7**

3. (a) Define Thomson scattering and prove that the Thomson scattering cross-section of a free charge particle is $\sigma_T = \left(\frac{8\pi}{3}\right)\left(\frac{q^2}{4\pi\varepsilon_0 \, mc^2}\right)^2$. **7**

OR

Discuss radiation damping phenomenon and obtain the damping coefficient is $l = \frac{e^2\gamma}{6\pi\varepsilon_0 c^3}$. **7**

(b) Define dispersion and dilute gases and prove that the dispersion relation for dilute gas is $n^2 = 1 + \sum_{\alpha} \frac{Nf_{\alpha}e^2}{m_{\alpha}\varepsilon_0}\left[\frac{1}{(\omega_{\alpha}^2 - \omega^2) - il_{\alpha}\omega}\right]$, write your comments. **7**

OR

(1) Prove that the Abraham-Lorentz formula for the radiation-reaction force is $\vec{a} = \vec{a}_0 \, e^{\frac{t}{\tau}}$ **3**

(2) Explain media containing free electrons with necessary example. **4**

4. (a) State the BNoltzman-Vlasov equation. Obtain the first and second moment equations and also write your comment. **7**

OR

(1) Prove that the ratio of isothermal to adiabatic is γ. **4**

(2) Derive Maxwell's thermodynamical equation $\left(\frac{\partial P}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$ **3**

(b) (1) For a fully ionized plasma, conductivity is infinite in collision less plasma, then show that

$$\vec{u}_\perp = \frac{\vec{E} x \vec{B}}{B^2}.$$ **3**

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

OR

Discuss : Two fluid model of plasma. **7**

5. Write short answers : **14**

1. Write matrix A^μ_v for proper velocity.
2. What will be the value of velocity if slope of the velocity against displacement is Asinx ?
3. What do you mean by stable and unstable limit cycle?
4. What will be the type of focal point for undamped oscillations?
5. Find the value of $(\Lambda^\mu_v)^2$.
6. What will be potential energy of simple pendulum for angular displacement 45°, mass of bob is 'm' and length of pendulum 'L' ?
7. Beyond the value of control parameter, logistic map become chaotic. [true/false]
8. Write Rayleigh's scattering expression for resonance condition.
9. Why sky is look dark at midnight ?
10. Define skin depth.
11. State the relation between dipole moment and dielectric susceptibility.

12. Define magneto hydrodynamics.

13. $\left(\frac{\partial f}{\partial t}\right)_{collision}$ is predominates __________ equation applicable and $\left(\frac{\partial f}{\partial t}\right)_{collisionless}$ is then ________ equation application.

14. In case of Liouville equation, why $f^{(N)}\big|_{t} = f^{(N)}\big|_{t+\Delta t}$? Write reason in one sentence.