Seat No. : _____

AC-152

April-2019

M.Sc., Sem.-II

408 : Physics
(Classical Mechanics-II. Electrodynamics and Plasma Physics)
(New Course / Old Course)

Time : 2:30 Hours] **[Max. Marks : 70**

Instructions : (1) Symbols and terminology have their usual meanings.

(2) Scientific calculator may be permitted.

1. (A) Write the following :

(i) Obtain an expression for the phase trajectory of a Simple pendulum. Hence discuss the three cases of phase trajectories for (a) $E_1 < 2mgl$, (b) $E_1 = 2mgl$, (c) $E_1 > 2mgl$. **7**

(ii) Obtain an expression for the time period of simple pendulum in terms of its amplitude (θ_0), i.e. obtain $T = \frac{4}{\omega_0} K(k)$, where $k = \sin\left(\frac{\theta_0}{2}\right)$. Evaluate the time period for $\theta_0 = 2°$ and $\theta_0 = 60°$. **7**

OR

(i) Discuss a system of two uncoupled harmonic oscillators and their phase trajectory. Hence discuss N-torus.

(ii) Write the differential equation for damped harmonic oscillator. Hence obtain parametric equations for the damped harmonic oscillator for $b^2 < \omega_0^2$, and $b^2 > \omega_0^2$. Draw the corresponding phase trajectories.

(B) Answer the following : (Any **four** out of **six**) : **4**

(1) Write the equation for of aperiodic motion, and draw corresponding phase trajectory.

(2) What is the representative point of phase plane ?

(3) Write the Van der Pol's equation.

(4) For the stability of fixed point in logistic map, logistic equation must satisfy the condition _____

(5) What do you mean by bifurcation ?

(6) What does Lyapunov exponent represent ?

2. (A) Write the following :

(i) Discuss relativistic momentum and relativistic energy. Show that when $u << c$, the relativistic kinetic energy approaches ordinary kinetic energy $mu^2/2$. Further show that a mass less particle ($m = 0$) must travel with speed of light, i.e. $u = c$ if $m = 0$. **7**

(ii) Write transformation equations for the components of electric field and magnetic field. Hence show that $\bar{E}.\bar{B}$ and $\bar{E}^2 - c^2\bar{B}^2$ are relativistically invariant. **7**

OR

(i) A pion at rest decays into a muon and a neutrino. Find the energy of the outgoing muon in terms of the two masses, m_π and m_μ (assming $m_\nu = 0$).

(ii) Using the transition from a discrete to a continuous system, obtain an expression for the Lagrangian density for an infinitely long elastic rod that can undergo small longitudinal vibrations.

(B) Answer the following : (Any **four** out of **six**) : **4**

(1) Write the transformation equations for the proper velocity 4-vector.

(2) Write an expression for the relativistic mass relating the rest mass.

(3) The time associated with the moving object is called _____ time.

(4) Write an equation relating Minkowski force with the normal force.

(5) When an object of mass m is at rest, its relativistic energy is _____

(6) What is the difference between invariant quantity and conserved quantity ?

3. (A) Answer the following :

(i) (1) State the relation between dipole moment and electric field for the bounded charges and then show that phase difference between P and E is changing from 0 to π. **7**

(2) Obtains = $\vec{a} = a_0 e^{\frac{t}{\tau}}$.

(ii) Derive the dispersion relation for dilute gases. **7**

OR

(i) Write Maxwell's equations in free space and derive the refractive index

$$\eta = 1 + \frac{1}{2}\frac{Ne^2}{m\varepsilon_0}\sum_\alpha \frac{f_\alpha(\omega_\alpha^2 - \omega^2)}{(\omega_\alpha^2 - \omega^2)^2 + l_\alpha^2\omega^2}.$$

(ii) Derive an expression for scattering of radiation by a bound charge particle.

(B) Answer the following : (Any **three** out of **five**) : **3**

(1) Why sky is dark at night ?

(2) Define radiation damping.

(3) State Abraham Lorentz force equation.

(4) What do you mean by dispersion is anamolous ?

(5) Define skin depth.

4. (A) Answer the following :

(i) Obtain Liouville equation for N- identical particles in 6-D space. **7**

(ii) Show that $\vec{a} = \frac{e}{m}\left[\vec{E} + \vec{u}x\vec{B}\right] + \frac{e}{m}\left[\vec{W}x\vec{B}\right] - \frac{d\vec{u}}{dt} - W\nabla_r.\vec{u}.$ **7**

OR

(i) State the Poission bracket for[D,H] and use it to obtain Liouville equation from the following relation $\frac{\partial D}{\partial t} + [D, H] = 0$

(ii) Discuss two fluid model of plasma in detail.

(B) Answer the following : (Any **three** out of **five**) **3**

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

(2) State the B-V equation for collision less plasma.

(3) Is there moment equations are interrelated to each other ? Give your comment.

(4) Define Magneto hydrodynamics.

(5) If collision is predominate then _____ equation applicable.

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