Gurudas College

M. Sc.(Physics) 2nd Semester Internal Examination 2021

Paper(Subject): PHY 421 (Classical Electrodynamics)

Time: 1Hr Full Marks:25

Answer any five questions from below.

1. Show that the linear momentum is conserved for a system of charged particles placed in an electromagnetic field. Define Maxwell's stress tensor. 4+1

2. Find the electric field and the magnetic induction in the radiation zone due to an oscillating electric dipole. 5

3. a)Find out dimension of A^μ field in Gaussian unit.
   b) What is the independent, nonzero, Lorentz invariant and parity invariant quantity which is constructed from field tensor $F^{\mu\nu}$? Express it in terms of electric and magnetic field. 2+(1+2)

4. Show that action $\int[-\frac{1}{16\pi}F_{\mu\nu}F^{\mu\nu} - \frac{1}{c}J^\mu A_\mu]d^4x$ will be invariant under gauge transformation $A_\mu \longrightarrow A'_\mu : A'_\mu = A_\mu + \partial_\mu\alpha$ provided current j^μ is conserved and localized in finite part of space time. Here α is space time dependent function. 5

5. For a point charge in accelerated motion, argue that the acceleration field contributes to radiated power but the velocity does not. Starting from the relativistic generalization of the Larmor's formula $P = -\frac{2}{3}\frac{e^2}{m^2c^3}\left(\frac{dp_\mu}{d\tau}\frac{dp^\mu}{d\tau}\right)$, (you may use MKS units) derive an expression for the radiated power when the velocity and acceleration of the particle are (i) parallel to each other and (ii) perpendicular to each other. 2+3

6. What is radiation reaction? Derive the Abraham-Lorentz formula for the radiation reaction force. What is the problem associated with this formula? 1+3+1

7. a) Write down Euler's equation of incompressible, viscous and conducting plasma in terms of the mass density ρ, velocity v, thermodynamic pressure P and magnetic field B.

b) What is 'pinch effect' of plasma? Write down the expression for the total current of a cylindrically pinched plasma column.
c) Determine the order of magnitude of current required for the purpose of confinement of hot plasma of density 10^{15} particles/cc at temperature 10^8 K, pressure 14 atmosphere and magnetic field 10^{19} K Gauss at the plasma surface. 1+(1+1)+2