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Sardar Patel University

M Sc. II Sem. Examination (physics)

Subject: PS02CPHY03 Electrodynamics and Plasma Physics

Day & Date: Saturday, 27 October 2018 Time: 10:00am to 1:00pm

Max. marks 70

Note: Symbols have their usual meaning.

I Choose the best possible answer from the choices given below each questions (8x1=8)

1. The wave equation for electromagnetic fields was possible due to the path breaking contribution of
   (a) Marconi (b) Faraday
   (c) Maxwell (d) Ampere

2. The electric field component of an electromagnetic wave propagating in x-direction can be written as
   (a) $\vec{E} = 05\sin(\omega t - 3x)\ \hat{y}$ (b) $\vec{E} = 05\sin(\omega t - 3x)\ \hat{x}$
   (c) $\vec{E} = 05\sin(\omega t - 3x)\ (\hat{x} + i\hat{y})$ (d) $\vec{E} = 05\sin(\omega t + 3z)\ \hat{z}$

3. For a good conductor the following relation is true
   (a) $\sigma \geq \frac{\varepsilon}{\omega}$ (b) $\sigma \leq \frac{\varepsilon}{\omega}$
   (c) $\sigma \geq \varepsilon\omega$ (d) $\sigma \leq \varepsilon\omega$

4. The quantity that corresponds to the instantaneous power density in electromagnetism is
   (a) the field energy vector (b) the field Intensity
   (c) the Lenz vector (d) Poynting vector

5. The lowest cutoff frequency for a rectangular wave guide occurs for the mode
   (a) TM_{11} (b) TE_{10}
   (c) TM_{01} (d) TE_{11}

6. For an electromagnetic wave in a good conducting medium, the following statement is true.
   (a) The magnetic field lags the electric field by 45^0
   (b) The electric field lags the magnetic field by 45^0
   (c) The magnetic field lags the electric field by 90^0
   (d) Both the electric and magnetic field lag by 45^0

7. The power radiated through synchrotron radiation by a relativistically moving charge particle is related to the particle's velocity factor γ as
   (a) γ^6 (b) γ^4 (c) γ^2 (d) γ^3

8. Landau damping is a
   (a) collision full damping (b) Coulomb assisted damping
   (c) two stream dominated damping (d) collision less damping

(PTO)

II Attempt any seven of the following short answer questions. **(7x2=14)**

1. Derive the continuity equation using the relevant Maxwell's equations.
2. Explain why metals are opaque?
3. Define cut off frequency of a wave guide and give an expression for the cutoff wavelength of a rectangular wave guide.
4. Calculate the radiation pressure generated by an EM wave (wavelength =586nm) of power 10W incident in an area of $2.5m^2$.
5. What are the different zones of radiation field around an extended source of radiation?
6. Define retarded time and derive a close expression for $\vec{\nabla} t_r$.
7. Draw the radiation pattern of Bremstrahlung and synchrotron radiations.
8. Derive the Boltzmann transport equation for the kinetic description of plasma
9. Explain the formation of sheath in plasma.

III A Write the four Maxwell's equations in Matter and explain the physical meaning of each of the equation. Further derive the boundary conditions satisfied by the **E, B, D** and **H** fields at the interface of two dielectric media. (6)

B Prove the Poynting's theorem in electrodynamics. Give its physical interpretation. (6)

OR

B. Define reflection and transmission coefficient of a plane wave at normal incidence at the interface of two dielectric media. (6)

IV A. Derive the dispersion relation in the case of electromagnetic wave propagating through a conducting medium. (6)

B. Obtain an expression for the electromagnetic stress tensor and show that the physical meaning of divergence of Stress tensor is "force per unit volume". (6)

OR

B. Define skin depth. Obtain an expression for the same and show that the skin depth in a good conductor is $\lambda/2\pi$, where λ is the wavelength of the electromagnetic wave in the conductor. (6)

V A. Explain different types of guided waves. Consider a rectangular wave guide with its cross section 2.0 cm x 1.0 cm. What are the lowest modes of the different types propagate in this wave guide, if the driving frequency is 1.7×10^{10}Hz. (6)

B. What is a Hertzian dipole antenna, compute the electric and magnetic field components and the time average power density radiated out by the antenna. (6)

OR

B. Derive the generalized Larmor formula for the case of radiation emitted by a relativistically moving point charge particle [Hint: $\vec{E}_R = \frac{q}{4\pi\varepsilon_0 r\ \xi^3}\hat{n}\times[(\hat{n}-\vec{\beta})\times\dot{\vec{\beta}}]$, where $\hat{n}$ is the unit vector along the propagation direction. Considering your own special case]. (6)

VI A Derive the momentum flow equation using Boltzmann's equation. (6)

B. Derive Abraham- Lorentz formula. (6)

OR

B. Explain ion acoustic shock waves using Sagdeev potential. (6)

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