Dr. AR Prepared by

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MANIPAL UNIVERSITY

DEPARTMENT OF SCIENCES

THIRD SEMESTER MSc END SEMESTER EXAMINATION NOV. – DEC. - 2016

SUBJECT: ELECTROMAGNETISM (PHY-703)

(CREDIT SYSTEM)

TIME: 3 HOURS MAX. MARKS: 50

Answer Any FIVE questions. Assume missing data, if any.

1. (a) What is Poisson's equation? How do you obtain Laplace's equation? Discuss how one can obtain the expression for potential in one and two-dimensional cases.

   (b) Consider a point charge q situated at a distance 's' from the centre of a grounded conducting sphere of radius R. Find the potential everywhere.

   (c) For a piece of polarized material consisting of several dipoles, calculate the scalar potential at a point outside the material. **[5+3+2]**

2. (a) Deliberate how the concept of vector potential is introduced in magnetostatics. Discuss the solution of vector potential for line, surface and volume currents.

   (b) What is auxiliary field? Quantitatively discuss its use in magnetostatics.

   (c) One of the following is an impossible electrostatic field. Which one?

   (i) $E=E_0[(xy)\, \boldsymbol{i} + (2yz)\, \boldsymbol{j} + (3xz)\, \boldsymbol{k}]$

   (ii) $E= E_0[\, y^2\, \boldsymbol{i} + (2xy + z^2)\, \boldsymbol{j} + (2yz)\, \boldsymbol{k}\,]$ **[4+3+3]**

3. (a) Derive the expression for energy and momentum associated with an electromagnetic wave (monochromatic plane wave).

   (b) For an EM wave obliquely incident at the interface of two media, derive the expression for reflected and transmitted electric field in terms of incident electric field.

   (c) Consider an EM wave propagating through sea water. The following data is given for sea water. Calculate the skin depth

   $\mu_0 = 4\pi \times 10^{-7}\ N/A^2$, $\varepsilon = 6 \times 10^{-10}\ C^2/N\ m^2$, $\sigma = 5\ \Omega\text{-m}$ **[4+4+2]**

4. (a) Consider a charge distribution in volume V. Derive the expression for force per unit volume in terms of Maxwell stress tensor.

(b) For a non-conductor through which a monochromatic EM is propagating, derive the expression for polarization, wave vector and absorption coefficient. Also discuss the concept of anomalous dispersion. **[5+5]**

5. (a) Consider two tiny metal spheres which are separated by some distance and are connected by a fine wire. Using appropriate approximations derive the expression for Poynting vector.

(b) Derive the expression for Lienard- Wiechert potentials.

(c) Using the concept of electromagnetic radiation, explain why sky appears blue.

[4+4+2]

6. (a) What are Coulomb and Lorentz gauge? Derive Lorentz force law using convective derivatives.

(b) Derive Maxwell's equations inside matter.

(c) When we suddenly plug in a toaster, we do not observe any spark, on contrary, a spark is seen when we suddenly unplug a toaster. **[4+4+2]**