ROLL NO. ___________________

Code: AE63/AE114 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **December 2016** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 Minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. Which one of the following expressions is incorrect?

(A) $\nabla . \boldsymbol{E} = \rho$ **(B)** $\nabla \times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t}$

(C) $\nabla . \boldsymbol{B} = 0$ **(D)** $\oint_l \boldsymbol{H}.\boldsymbol{dl} = \int_s (J + \frac{\partial D}{\partial t}).\boldsymbol{a}_n dS$

b. Which one of the following units of the magnetic vector potential is incorrect?

(A) Tm **(B)** HA/m

(C) Vs/m **(D)** HA

c. The unit of the expression $\oint_S \boldsymbol{D}.\boldsymbol{dS} = \oint_S \boldsymbol{D}.\boldsymbol{a}_n dS$ is

(A) C **(B)** V

(C) C/m^2 **(D)** V/m

d. $\nabla . \boldsymbol{B} = 0$ means

(A) Magnetic field vector is always irrotational and magnetic field lines originate from the north pole of a magnet and terminate on its south pole.

(B) Magnetic field vector is always solenoidal and magnetic field lines originate from the north pole of a magnet and terminate on its south pole.

(C) Magnetic field vector is always solenoidal and magnetic field lines are continuous.

(D) Magnetic field vector is always irrotational and magnetic field lines are continuous.

e. Which one of the following expression is incorrect?

(A) $\nabla . \boldsymbol{A} = -\mu_0 \epsilon_0 \frac{\partial V}{\partial t}$ **(B)** $\nabla^2 \boldsymbol{A} - \mu_0 \epsilon_0 \frac{\partial^2 A}{\partial t^2} = \mu_0 \boldsymbol{J}$

(C) $\boldsymbol{H} = \frac{\nabla \times A}{\mu_0}$ **(D)** $\nabla \times \boldsymbol{B} = \mu_0 J + \mu_0 \frac{\partial \boldsymbol{D}}{\partial t}$

f. The quantity E associated with a wave propagating along the negative Z-direction can be represented by
(A) $E = E_0 \exp\,(\omega t - \beta z)$ **(B)** $E = E_0 \cos\,(\omega t + \beta z)$
(C) $E = E_0 \exp\omega\,(t - z/v_{ph})$ **(D)** $E = E_0 \cos\,(\omega t - \beta z)$
where ω, β and v_{ph} are the wave angular frequency, phase propagation constant and phase velocity respectively.

g. The unit of volume charge density ρ_v is
(A) C **(B)** C/m^2
(C) C/m **(D)** C/m^3

h. Skin depth is given by:
(A) $\delta = \sqrt{\frac{2}{\omega\mu\sigma}}$ **(B)** $\delta = \sqrt{\frac{1}{\omega\mu\sigma}}$
(C) $\delta = \sqrt{\frac{1}{2\omega\mu\sigma}}$ **(D)** None of these

i. Given $\boldsymbol{A} = x^2\boldsymbol{a}_x + yz\boldsymbol{a}_y + xy\boldsymbol{a}_z$, find $\nabla.\boldsymbol{A}$.
(A) 4x+y **(B)** 2x+z
(C) x+z **(D)** 0

j. Divergence theorem is given by :
(A) $\int \boldsymbol{D}.d\boldsymbol{S} = \int(\nabla \times \boldsymbol{D})dv$ **(B)** $\int\int \boldsymbol{D}.d\boldsymbol{S} = \oint(\nabla.\boldsymbol{D})dv$
(C) $\oint \boldsymbol{D}.d\boldsymbol{S} = \int(\nabla.\boldsymbol{D})dv$ **(D)** None of these

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Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Charge lies in the $z = -3m$ plane in the form of a square sheet defined by $-2 \le x \le 2m, -2 \le y \le 2m$ with charge density $\rho_s = 2(x^2 + y^2 + 9)^{3/2} nC/m^2$. Find **E** at the origin. **(8)**

b. A Charge point $Q = 30\ nC$, is located at the origin in Cartesian coordinates. Find the electric flux density D at $(1,3,-4)m$. **(8)**

Q.3 a. State and prove Uniqueness Theorem. **(10)**

b. Derive Poisson's and Laplace's equations. **(6)**

Q.4 a. We have a square loop of wire in the z=0 plane carrying 2 mA in the field of an infinite filament on the y axis, as shown in the Fig. below. We desire the total force on the loop.

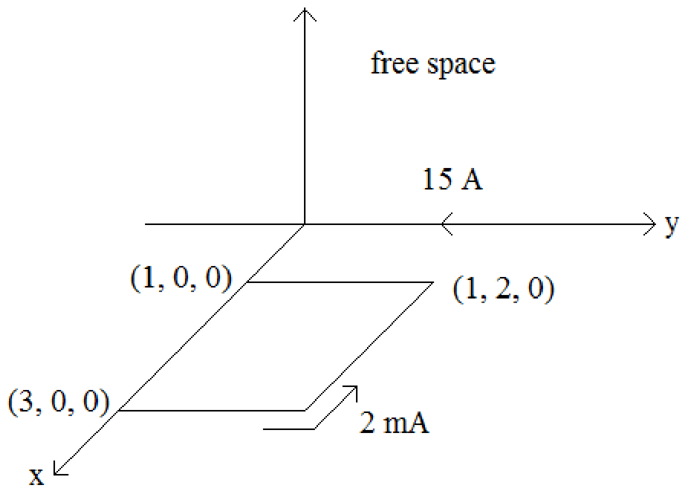

Fig.: A square loop of wire in the xy plane carrying 2 mA is subjected to a nonuniform B field. **(8)**

b. Give the expression of force on a differential current element. **(8)**

Q.5 a. Derive the electrostatic energy density expression as $w_E = \frac{1}{2}\mathbf{D}\bullet\mathbf{E} = \frac{1}{2}\varepsilon E^2 \left[\frac{J}{m^3}\right]$, where w_E =electrostatic energy density, D=Electric flux density, ε = permittivity. **(8)**

b. Find the potential at $r_A = 5m$ with respect to $r_B = 15m$ due to a point charge 500 pC at the origin and zero reference at infinity. **(8)**

Q.6 a. Derive Stokes' theorem and state its application. **(8)**

b. What is the inconsistency towards Ampere's circuital law and give the modification to it. **(8)**

Q.7 a. Show that $B(x,y,z) = \frac{\mu}{4\pi}\int_a^b \frac{Idl' \times \hat{R}}{|R|^2}$ [T], using Biot-Savart Law. **(8)**

b. Find H at the center of a square loop of side L. **(8)**

Q.8 a. Explain the various types of ionization levels (D, E, F_1, F_2) in the sky wave propagation. **(8)**

b. Explain the principle of superrefraction or duct propagation using a neat sketch. **(8)**

Q.9 a. Draw the schematic of Dish-Parabolic antenna. Explain its operating principle. What are the shortcomings of this antenna? **(8)**

b. Write short notes on Ground wave propagation. **(8)**