ROLL NO. _____

Code: AE63/AE114 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **JUNE 2017** **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. Charge needed within a unit sphere centered at the origin for producing a potential field, $V = -\frac{6r^5}{\varepsilon_0}$ for $r \le 1$ is

(A) 12Pc **(B)** 60Pc

(C) 120Pc **(D)**180Pc

b. A plane electromagnetic wave travels in dielectric medium of relative permittivity 9. Relative to free space, the velocity of propagation in the dielectric is

(A) increased by a factor of 9 **(B)** increased by a factor of 3

(C) unchanged **(D)** reduced by a factor of 1/3

c. In a 100 turn coil, if the flux through each turn is $(t^3 - 2t)$mWb, the magnitude of the induced emf in the coil at a time of 4 sec is

(A) 46mV **(B)** 56mV

(C) 4.6V **(D)** 5.6V

d. A material has conductivity of 10^{-2} mho/m and a relative permittivity of 4. The frequency at which conduction current in the medium is equal to displacement current is _____MHz.

(A) 45 **(B)** 90

(C) 450 **(D)** 900

e. Poynting vector is associated with which of the following?

(A) Power flow in electromagnetic field

(B) Flux in magnetic field

(C) Charge in electrostatic field

(D) Current in electrostatic field

f. Find the flux crossing the plane surface defined by $0.5 \le r \le 3.5$ m and $0 \le z \le 3$m, if $\vec{B} = \frac{20}{\pi}\hat{a}_r(t)$

(A) 0 **(B)** 255Wb
(C) 6.45Wb **(D)** None of these

g. For static magnetic field, Maxwell's curl equation is given by

(A) $\nabla . \vec{B} = \mu_0 \vec{J}$ **(B)** $\nabla \times \vec{B} = 0$
(C) $\nabla \times \vec{B} = \mu_0 \vec{J}$ **(D)** $\nabla \times \vec{B} = \mu_0 / \vec{J}$

h. For F_1 layer the maximum ionic density is 2.3×10^4 electrons per cc. The critical frequency for this layer will be

(A) 1.36 MHz **(B)** 13.6 MHz
(C) 136 MHz **(D)** 1360 MHz

i. The radiation resistance of a λ/16 wire dipole in free space will be nearly

(A) 1 Ω **(B)** 3 Ω
(C) 13 Ω **(D)** 30 Ω

j. Maximum effective aperture of an antenna which is operating at a wavelength of 3 meters and has a directivity of 100, is

(A) 71.68 m^2 **(B)** 716 m^2
(C) 7.16 m^2 **(D)** 71.6 m^2

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

Q.2 a. The magnetic field intensity vector of a plane wave is given by $\vec{H}(x, y, z, t) = 10 \sin(5000t + 0.004x + 30\ \hat{a}_y)$, where $\hat{a}_y$ denotes unit vector in *y* direction. Find the phase velocity of the propagating wave. **(8)**

b. The Depth of penetration of EM wave in medium having conductivity σ at a frequency of 1 MHz is 25 cm. Compute the depth of penetration at a frequency of 4 MHz . **(5)**

c. State and prove coulomb's law. **(3)**

Q.3 a. Define and explain vector magnetic potential. Derive an expression for vector magnetic potential. **(4+4)**

b. Derive standard wave equations. Show the application of wave equations. **(6+2)**

Q.4 a. Explain the significance of boundary conditions in electromagnetic problems. Give an example. **(8)**

b. State and derive uniqueness theorem. **(8)**

Q.5 a. Compute the torque (in mm) acting on a circular current loop of radius 1 mm in the *xy* plane, connected at the origin and with current 0.1 A, flowing in the sense of increasing in a magnetic field $\hat{B} = 10^{-5}(2\hat{a}_x - 2\hat{a}_y + \hat{a}_z)$ $\omega b/m^2$. **(6)**

b. Derive an expression for energy stored in magnetic field. **(6)**

c. State and derive Stoke's theorem. **(4)**

Q.6 a. Define and explain self and mutual inductance. Differentiate them. **(8)**

b. Write short notes on (i) Magnetic materials (ii) Force between different current elements **(2x4)**

Q.7 a. Derive the Poisson's and Laplace's equations. **(8)**

b. The magnitude of E field for a plane wave traveling in free space is 100volts per meter. Find the average pointing vector and the power flow through a surface of $4m^2$ that is perpendicular to the direction of propagation. **(8)**

Q.8 a. Define and explain LOS propagation with a diagram. If the height of transmitting and receiving antenna in a LOS system are 49 meter and a 9 meter respectively then find the distance up to which communication may be possible. **(8)**

b. Explain the factors that influence the propagation of radio waves. **(8)**

Q.9 a. Explain the construction and principle of pyramidal horn antenna. A pyramidal horn antenna having aperture dimensions of a= 5.2cm and b= 3.8cm is used at a frequency of 10 GHz. Calculate its gain and half power beam widths. **(4+4)**

b. Draw a 3 element Yagi – Uda antenna and explain its construction and principle of operation. **(8)**