ROLL NO. _____

Code: AE63/AE114 Subject: ELECTROMAGNETICS & RADIATION SYSTEMS

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **DECEMBER 2018** **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. Two small identical conducting spheres separated by 4 cm have charges –2 nC and 1 nC respectively. What is the force between them?
(A) 251.1 x 10^{-6} N **(B)** 1.125 x 10^{-5} N
(C) 1.125 N **(D)** 1.125 x 10^{-8} N

b. A circular coil of radium 10 cm is made up of 200 turns. It carries a current of 2.5 A. What is the magnetic field intensity at the centre of the coil?
(A) 25 AT/m **(B)** 250 AT/m
(C) 2500 AT/m **(D)** 25 x 10^{-4} AT/m

c. Unit of magnetic vector potential is
(A) Ampere/m^2 **(B)** Ampere/m
(C) Weber/m **(D)** Weber/m^2

d. An electron beam moves along x direction and subjected to electric field along x direction and magnetic fields in y direction. The path of the electron beam will be
(A) straight line along x direction
(B) circular motion in plane perpendicular to x direction
(C) helical motion along x direction
(D) parabolic motion normal to x direction

e. Faraday's law is valid for both open and closed loops. The Lentz's law is valid for
(A) only open loop **(B)** only closed loop
(C) Both open and closed loop **(D)** None of these

f. In a given medium, $\sigma/\omega\varepsilon = 1.732$. The magnetic field and electric field are out of phase by
(A) 15º **(B)** 30º
(C) 60º **(D)** 90º

g. Electromagnetic wave is incident on a dielectric conductor interface at a certain angle 30º. The non-zero electric field E will be always at an angle
(A) 0° **(B)** 30°
(C) 60° **(D)** 90°

h. Tropospheric scatter is used with frequencies in the following range
(A) HF **(B)** UHF
(C) VHF **(D)** VLF

i. Which of the following layers persists at night?
(A) D layer **(B)** E layer
(C) F_1 layer **(D)** F_2 layer

j. Which of the following can radiate a circularly polarised electromagnetic wave?
(A) Yagi-Uda antenna **(B)** a small circular loop
(C) parabolic reflector antenna **(D)** a helical antenna

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

Q.2 a. State Coulomb's law.
Eight identical point charges of Q C each are located at the corners of a cube of side length a, with one charge at the origin and with the nearest charges at (a,0,0), (0,a,0) and (0,0,a). Find an expression for the total vector force on the charges at P(a,a,a), assuming free space. **(2+6)**

b. State and prove the Divergence theorem. **(8)**

Q.3 a. Explain electric potential and electric field intensity. Derive a relation between them. **(7)**

b. Describe the boundary conditions at the interface of two perfect dielectric media. Calculate the capacitance of a parallel plate capacitor having two dielectric layers between the plates: one is mica (ε_r=6) of thickness 1 mm and other is air of thickness 2 mm, with a plate area of 100 m^2. **(9)**

Q.4 a. State and prove Uniqueness Theorem. **(8)**

b. The conducting plates 2x + 3y =12 and 2x + 3y = 18 are at potentials of 100V and 0V, respectively. Let $\varepsilon = \varepsilon_0$ and find potential and electric field at P(5,2,6). **(8)**

Q.5 a. Determine magnetic vector potential for **(8)**
(i) line current
(ii) sheet current
(iii) volume current

b. A filamentary conductor is formed into an equilateral triangle with sides of length *l* carrying current I. Find the magnetic field intensity at the centre of the triangle. **(8)**

Q.6 a. Derive the expression for force and torque exerted by a closed circuit in presence of a steady magnetic field. **(6)**

b. What are the different kinds of magnetic materials? **(3)**

c. A solenoid is 50 cm long, 2 cm diameter and contains 1500 turns. The cylindrical core has a diameter of 2 cm and relative permeability of 75. This coil is coaxial with a second solenoid also 50 cm long, but with a 3 cm diameter and 1200 turns. Calculate (i) self –inductance L for the inner solenoid, (ii) L for the outer solenoid and (iii) mutual inductance between the two solenoids. **(2+2+3)**

Q.7 a. Write down Ampere's circuital law and continuity equation. Why did Maxwell modify the Ampere's circuital law? What is displacement current? **(8)**

b. Given $\mathbf{E} = E_m \sin(wt-\beta x)\, \mathbf{a}_y$, in free space, find **D**, **B**, **H**. Sketch **E** and **H** at t=0. **(8)**

Q.8 a. What is troposphere? Why does refraction of radio wave occur in the atmosphere? **(6)**

b. Discuss duct propagation. **(4)**

c. Two points on earth are 1600 km apart and are to communicate by means of HF. Given that this is to be a single-hop transmission, the critical frequency at that time is 7 MHz and conditions are idealized, calculate the MUF for those two points if the height of the ionosphere layer is 320 km. **(6)**

Q.9 a. What do you mean by Cassegrain method of feeding a paraboloid reflector? **(3)**

b. Explain the operation of a Yagi-Uda antenna. List its applications. Why is it called a super gain antenna? **(8)**

c. If antenna radiation resistance is 100 Ω and the radiation efficiency is 75%, what is the antenna resistance? **(5)**