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Question Paper Code : 90515

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Third/Seventh Semester

Electrical and Electronics Engineering

EE 8391 – ELECTROMAGNETIC THEORY

(Common to: Electronics and Instrumentation Engineering, Instrumentation and Control Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the properties of divergences of vector field.
2. A Charge is distributed on x axis of Cartesian system having a line charge density of $3x^2$C/m. Find the total charge over the length of 10 m.
3. A point charge Q = 0.4 n C is located at the origin. Obtain the absolute potential of A(2, 2,3).
4. Find the polarization in dielectric material with $\varepsilon_R = 2.8$ if $\overline{D} = 3 * 10^{-7}\, C/m^2$.
5. What is energy density in magnetic field?
6. Write Laplace's equation for scalar magnetic potential.
7. State Maxwell's third equation.
8. State point form of ohms law.
9. Mention the properties of uniform plane wave.
10. Define intrinsic impedance or characteristic impedance.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Find the divergence and curl of the following function: $\overline{A} = 2xy\,\overline{a}_x + x^2 z\,\overline{a}_y + z^3\,\overline{a}_z$. (7)

(ii) Express the field $\overline{E} = \frac{A}{x^2}\overline{a}_r$ in (1) rectangular components, (2) cylindrical components. (6)

Or

(b) (i) Four point charges each of $10\mu C$ are placed in free space at the points (1, 0 , 0), (-1, 0, 0), (0, 1, 0) and (0, -1, 0) m respectively . Determine the force on a point charge of $30\,\mu$C located at a point (0,0, 1)m. (7)

(ii) A sphere of radius 2 cm is having volume charge density of ρ_v given by $\rho_v = \cos^2\theta$. Find the total charge Q contained in the sphere. (6)

12. (a) A total charge of 10^{-8}C is distributed uniformly along with the radius 5 m. calculate the potential of the axis of the ring at appoint 5 m from the centre of ring. If the same charge is uniformly distributed on a disc of 5 in radius, what will be the centre of the potential on its axis at 5 m from the centre

Or

(b) Discuss Boundary conditions between conductor and free space when electrostatic field crosses.

13. (a) Derive $\overline{H}$ the magnetic field intensity due to straight conductor of finite length carrying direct current 'I'.

Or

(b) Find out the magnetic vector potential in the vicinity of a very long straight wire carrying a current I. Hence find magnetic field density and magnetic field strength.

14. (a) (i) If the magnetic field $\overline{H} = [3x\cos\beta + 6y\sin\alpha]\overline{a}_z$ find current density $\overline{J}$ if fields are invariant with time. (6)

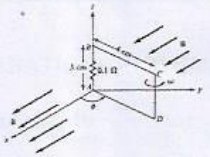
(ii) An area of 0.65 m² in the plane z = 0 encloses a filamentary conductor. Find the induced voltage if, $\overline{B} = 0.05\cos 10^3 t\left(\frac{\overline{a}_y + \overline{a}_z}{\sqrt{2}}\right)$ Tesla. (7)

Or

(b) A loop shown in the figure is inside a uniform magnetic field $B = 50\,\overline{a}_x\, mWb/m^2$. If side DC of the loop cuts flux lines at frequency of 50 Hz and the loop lies in the y-z plane at t = 0, find

(i) the induced e.m.f. at t = 1 ms. (7)

(ii) the induced current at t 3 ms. (6)



15. (a) Derive and summarize the equations which describe propagation of uniform plane waves in free space.

Or

(b) Derive and summarize the equations which describe propagation of uniform plane waves in lossy dielectric medium.

PART C — (1 × 15 = 15 marks)

16. (a) An electrostatic field is given by, $\overline{E} = -8xy\,\overline{a}_x - 4x^2\overline{a}_y + \overline{a}_z\, V/m$ The charge of 6 C is to be moved from B (1, 8, 5) to A (2, 18, 6). Find the work done in each of the following cases.

(i) The path selected is $y = 3x^2 + z, z = x + 4$ (7)

(ii) The straight line from B to A. (8)

Show that work done remaining same and is independent of the path selected.

Or

(b) Do the fields $\overline{E} = E_m \sin x \sin t\,\overline{a}_y$ and $\overline{H} = \frac{E_m}{\mu_0}\cos x \cos t\,\overline{a}_z$ satisfy Maxwell's equations?