QP Code:EE2T07-1 **(Pages:3)**

Reg No : ..... Name : .....

MAR ATHANASIUS COLLEGE OF ENGINEERING, KOTHAMANGALAM

(Govt. Aided Autonomous Institution)

Fourth Semester B.Tech. Degree Examination, May, 2026

Course Code: B24EE2T07

Course Name: ELECTROMAGNETIC THEORY

Max. Marks: 100 Duration:3 Hours

PART - A: 30 Marks (10 Qns x 3 Marks)

Answer all questions

1. Explain the physical significance of dot product with an example.
2. State Coulomb's law and express the vector forces $\bar{F}_1$ and $\bar{F}_2$ acting on two point charges q_1 and q_2 respectively, separated by a distance r in free space.
3. Write the expression for the capacitance of parallel good conductors and define all the terms involved.
4. Sketch the equipotential surfaces due to a positive point charge and describe their nature.
5. Define magnetic flux density. Write its SI unit and give its relation with magnetic flux.
6. Define the curl of a vector field and explain its physical significance.
7. Define the Poynting Vector.
8. Explain the significance of skin depth in electromagnetic waves.
9. Discuss one method to avoid electromagnetic interference.
10. State the condition for a transmission line to be lossless.

PART - B: 70 Marks (5 Qns x 14 Marks)

Answer any One full question from each module.

Module 1

11. A vector field is given by the expression

    (i) $\bar{F} = (\frac{1}{r})\hat{a_\rho}$ in cylindrical co-ordinates

    (ii) $\bar{F} = (\frac{1}{r})\hat{a_r}$ in spherical co-ordinates

    Determine $\bar{F}$ in each case in Cartesian form, at a point with $(1, 1, 1)$.

OR

12. a. Using Gauss's law, derive the expression for the electric field intensity due to an infinitely long line charge with linear charge density ρ_L c/m. (7 Marks)

b. Due to point charge -5 μC located at $(4, 0, 0)$ and an infinite line charge of 3 $\mu C/m$ along the y - axis, determine the electric flux density at $(4, 0, 3)$. (7 Marks)

Module 2

13. a. Given a vector field $\bar{F} = \rho cos\phi(\hat{a_\rho} + z\hat{a_\phi})$ in a cylindrical coordinate system, verify the divergence theorem for the region $(0 \leq z \leq 2, \rho = 2)$. (9 Marks)

b. What is divergence? Define divergence of a vector field in Cartesian coordinates. (5 Marks)

OR

14. a. A charge of 1 C is placed at point $(2, 0, 0)$, and another charge Q is placed at point $(-2, 0, 0)$. Find the value of Q which will make the y component of the total electric field intensity zero at the point $(1, 2, 2)$. (7 Marks)

b. What is the potential at the centre of a square with side 2 m length, when the charges 2 μC, -4 μC, 6 μC and 2 μC are located at its four corners? (7 Marks)

Module 3

15. Starting from basic electromagnetic laws, obtain Maxwell's equations in integral and differential forms for time-varying fields. Discuss their physical meaning

OR

16. a. With neat sketches, derive the boundary conditions of the electric field for a conductor at a dielectric interface. (9 Marks)

b. Explain the modification required to make Ampere's circuital law consistent under a time-varying field. (5 Marks)

Module 4

17. a. Explain the propogation of uniform plane waves in a lossless dielectric medium. (9 Marks)

b. Explain the significance of intrinsic impedance. (5 Marks)

OR

18. a. A lossy dielectric material is characterized by $\mu = 2\mu_0$, $\epsilon = 2\epsilon_0$, and $\sigma = 0.03$ S/m. If electric field $\overline{E} = 3e^{-\gamma z}\hat{a_y}\, V/m$, at a frequency of 30 MHz, determine i) propagation constant, ii) Intrinsic impedance, iii) Magnetic field of the wave. (10 Marks)

b. Distinguish between lossy and perfect dielectric. (4 Marks)

Module 5

19. a. Derive an equation for voltage and current at any point on a transmission line. (9 Marks)

b. A lossless transmission line operating at $4.5\,GHz$ has $L = 2.4\,\mu H/m$ and characteristic impedance $Z_0 = 85\,\Omega$. Calculate phase constant and capacitance per meter. (5 Marks)

OR

20. a. A low-loss coaxial transmission line with a characteristic impedance of $75\ \Omega$ is terminated with a resistive load of $25\ \Omega$. Calculate the voltage standing wave ratio on the line. Also find the minimum voltage if the maximum voltage on the standing wave pattern is $20\,V$ and discuss the change in VSWR when the maximum is reduced to $15\,V$, keeping the minimum voltage same. (8 Marks)

b. Define standing wave ratio? What is the value of standing wave ratio for short circuited line. (6 Marks)

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