Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B. TECH DEGREE EXAMINATION (R,S), MAY 2024
ELECTRONICS AND COMMUNICATION ENGINEERING
(2020 SCHEME)

Course Code : 20ECT302

Course Name: Electromagnetics

Max. Marks : 100 **Duration: 3 Hours**

Smith Chart to be supplied on request.

PART A

(Answer all questions. Each question carries 3 marks)

1. Formulate an expression to find electric field intensity for a system of point charges.
2. For a vector field A, show that $\nabla . \nabla XA = 0$.
3. Derive the relation between scalar potential and vector potential.
4. Derive continuity equation from fundamental laws.
5. State Poynting's Theorem along with its mathematical expression.
6. Explain the different types of wave polarization.
7. State Snell's law. What is its significance in wave propagation?
8. A lossless transmission line has primary constant L = 0.01μH/m, C = 100pF/m. Find the characteristic impedance of the line.
9. Explain the propagation of electromagnetic wave in a rectangular waveguide.
10. Elaborate on dominant modes in rectangular waveguides.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) In a certain material $\sigma = 0$, $\mu = \mu_0$ and $\epsilon = 81\epsilon_0$. The magnetic field intensity in this material is $\boldsymbol{H}=10\cos(2\pi\times10^9\, t + \beta x)\, \boldsymbol{a}_z$ A/m. Determine $\boldsymbol{E}$ and β. (7)

    b) Point charges 5nC and -2nC are located at (2, 0, 4) and (-3, 0, 5), respectively. (7)
    i) Determine the force on a 1nC point charge located at (1, -3, 7).
    ii) Find the electric field **E** at (1, - 3, 7).

OR

12. a) Current sheets of 20 $\boldsymbol{a}_x$ A/m and −20 $\boldsymbol{a}_x$ A/m are located at $y = 1$ and $y = -1$ respectively. Find $\boldsymbol{H}$ in the region $-1 < y < 1$. (7)

b) Explain Poisson's and Laplace equation in electrostatics with necessary equations. Give application for each. (7)

MODULE II

13. a) Formulate an expression to find the capacitance of a two-wire transmission line. (7)

b) State and prove boundary conditions for **E** and **H** in accordance with Maxwell's equations. (7)

OR

14. a) Formulate Maxwell's equation for electromagnetic fields from the basic laws of electric field and magnetic field. (8)

b) Formulate an expression to find the inductance of a coaxial cable. (6)

MODULE III

15. a) Analyze wave propagation and solution of the wave equation in a lossless dielectric medium. Also, derive the expressions for (7)
    i) Attenuation constant
    ii) Phase velocity
    iii) Phase constant
    iv) Intrinsic impedance

b) Analyze the behaviour of a plane electromagnetic wave with parallel polarization when it is incident at an angle at the boundary of two lossless media at $z = 0$. (7)

OR

16. a) Analyze the behaviour of a plane electromagnetic wave when it is incident normally at the boundary of a perfect dielectric and a perfect conductor at $z = 0$. (8)

b) State and explain skin depth. For a good conductor, prove that $\alpha = \beta$, where, α is the attenuation constant and β is the phase constant. (6)

MODULE IV

17. a) Derive transmission line equation and the expressions for (6)
    i) Propagation Constant
    ii) Characteristic Impedance
    iii) Input impedance

b) A $25 + j100\ \Omega$ load is connected to a $50\ \Omega$ lossless transmission line. Using smith chart, find (8)
    i) Reflection coefficient at load
    ii) VSWR
    iii) Load admittance
    iv) Input impedance at $0.2\ \lambda$ from the load

OR

18. a) A lossless 50 Ω transmission line of length 3.2 m is terminated with an impedance of 30-j50 Ω. If the line operates at a frequency of 400MHz, determine the input impedance. (6)

b) A 100+j150Ω load is connected to 75Ω lossless line. Using smith chart find (8)

i) Reflection coefficient
ii) Standing Wave Ratio
iii) The load admittance Y_L
iv) Z_{in} at 0.4λ from the load
v) The locations of voltage maximum and voltage minimum with respect to the load if the line is 0.6λ long.

MODULE V

19. a) Derive the expression for all the electric and magnetic field components of a rectangular waveguide in Transverse Magnetic Mode. (8)

b) For TE_{10} mode of propagation in a rectangular wave guide, with length 8cm and 6 cm respectively, find the following when frequency of operation is 6 GHz. (6)

i) Cut off frequency
ii) Cut off wavelength
iii) Guide wavelength
iv) Phase constant
v) Phase velocity
vi) Wave impedance

OR

20. a) Derive the expression for all the electric and magnetic field components of a rectangular waveguide in Transverse Electric Mode. (8)

b) Consider a TM_{13} propagating inside a rectangular waveguide having a = 3 cm, b = 1.6 cm, $\sigma = 0$, $\mu = \mu_0$, $\epsilon = 4\epsilon_0$ and (6)
$H_x = 2\ sin(\pi x/a)\ \cos(3\pi y/b)\ \sin(\pi \times 10^{11}t - \beta z)$ A/m.
Determine

i) Cut-off frequency
ii) Cut off wavelength
iii) Phase constant
iv) Propagation constant
v) Intrinsic impedance.

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