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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (S, FE) / S4 (PT) (S,FE) Examination December 2024 (2019 Scheme)

Course Code: ECT302

Course Name: ELCTROMAGNETICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1 Verify that the vector field $A=yz\,a_x+zx\,a_y+xy\,a_z$ is both irrotational and also solenoidal (3)

2 State Ampere's circuit law and obtain its expression in point form (3)

3 A parallel plate capacitor with plate area of $5cm^2$ and plate separation of 3mm has a voltage $50\sin 10^3 t$ V applied to its plates. Calculate the displacement current assuming $\varepsilon=2\varepsilon_0$ (3)

4 State the boundary conditions for electric field components that are tangential and normal at the interface between two dissimilar dielectric materials. (3)

5 What is Brewster angle? (3)

6 Calculate the skin depth for copper when an electromagnetic wave is incident normally. Given that frequency of the wave is 30 MHz $\mu r=1$ and conductivity $=5.8\times10^7$ mho/m. (3)

7 Distinguish between Lossless line and Distortionless line (3)

8 A transmission line with a characteristic impedance of 300Ω is terminated in a purely resistive load. It is found by measurement that the minimum line voltage upon it is 5μV and maximum 7.5 μV. What is the value of load impedance? (3)

9 Differentiate between group velocity and phase velocity in wave propagation within a waveguide (3)

10 Describe the terms in a waveguide: i) Dominant mode ii) Cut-off frequency (3)

PART B

Answer one full question from each module, each carries 14 marks.

Module I

11 a) i) For a scalar field V, prove that $\nabla X\nabla V=0$ that is the curl of the gradient of any scalar field is zero. (8)

ii) For a vector field **A**, prove that $\nabla.\nabla \times \mathbf{A}=0$ that is the divergence of the curl of any vector field is zero.

b) Two point charges -4μC and 5μC are located at (2,-1, 3) and (0, 4,-2) respectively. Find the potential at (1, 0, 1) assuming zero potential at infinity. (6)

OR

12 a) Given the potential field, $V=2x^2y-5z$ and a point P (-4, 3, 6). At point P, calculate (8)
i) The potential V ii) The electric field intensity E
iii) The electric flux density, **D** iv)Volume charge density, ρ_v.

b) Determine the divergence of the following vector fields and evaluate them at the specified points. (6)
i) $\mathbf{A}=yz\mathbf{a}_x+4xy\mathbf{a}_y+y\mathbf{a}_z$ at (1,-2,3)
ii) $\mathbf{B}=\rho z \sin\Phi\, \mathbf{a}_\rho+3\, \rho z^2 \cos\Phi \mathbf{a}_\Phi$ at $(5,\pi/2,1)$

Module II

13 a) Explain the concepts of magnetic scalar and vector potentials, including the conditions under which each of these potentials exists. (8)

b) Derive the expression of capacitance for coaxial cable. (6)

OR

14 a) State and Explain Maxwell's equations for time varying fields in the integral and differential forms (8)

b) The point charges -1nC, 4nC and 3nC are located at (0, 0, 0), (0, 0, 1) and (1, 0,0) respectively. Find the energy in the system. (6)

Module III

15 a) For a plane wave propagating in a lossy dielectric, derive the expression for Propagation constant. (8)

b) In free space, Expression of Electric field of a plane wave is given by (6)
$E = 30 \cos(10^8 t - \beta x)\, \mathbf{a}_y$, Find
i). Direction of propagation ii). Intrinsic Impedance
iii). Expression of Magnetic field iv). Attenuation constant
v). Phase constant vi). Skin depth

OR

16 a) Derive the expression for Brewster angle for parallel polarised wave (8)

b) Compute phase velocity, phase constant and intrinsic impedance for 1MHz plane wave in a large block of copper. $\sigma=5.8\times10^7$ S/m; $\varepsilon_r=1$ and $\mu r=1$. (6)

Module IV

17 a) A distortionless line at 150MHz has $Z_0=75\ \Omega$, $\alpha=0.06$Np/m and $u=2.8\times10^8$m/s. Calculate the line parameters R,G,C and L. (8)

b) What is Wave polarization? What are the different types of polarisation? (6)

OR

18 a) Derive the expression of input impedance due to a transmission line terminated by a load Z_L (8)

b) In a non-magnetic medium, $E=4\sin(2\pi\times10^7t-0.8x)\ \mathbf{a}_z$ V/m (6)

Find i) the relative permittivity, ε_r, Intrinsic impedance, η ii) The time average power carried by the wave. iii) The total power crossing $100cm^2$ of plane $2x+y=5$

Module V

19 a) A load of $100+j150\pi\ \Omega$ is connected to a $75\ \Omega$ lossless line, using Smith chart (7)

Find i) Reflection coefficient, Γ ii) Standing wave ratio, s

iii) Load admittance Y_L iv) Z_{in} at 0.4λ from the load

b) In an air-filled rectangular waveguide with a TE mode is operating at 6 MHz has (7)

$E_Y=5\sin(2\pi x/a)\cos(\pi y/b)\sin(\omega t-12z)$ V/m

Determine i) The cut off frequency ii) H_X

iii) The intrinsic impedance

OR

20 a) Derive the expression for Electric and magnetic field intensities for TM mode of propagation of rectangular waveguide. (8)

b) A $70\ \Omega$ lossless line has s=1.6 and $\theta_\Gamma=300^0$. If the line is 0.6λ, Using Smith Chart Obtain (6)

i) Reflection Coefficient, Γ ii) Load Impedance, Z_L iii) Input Impedance, Zin

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