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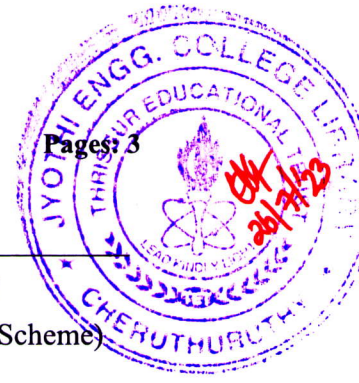
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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R, S) / S4 (PT) (R,S) Examination June 2023 (2019 Scheme)



Course Code: ECT302

Course Name: ELECTROMAGNETICS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

Marks

- 1 Define divergence and state divergence theorem. (3)
- 2 Write all equations for transforming a vector field from cylindrical to rectangular coordinates. (3)
- 3 What are the equations representing the governing laws for time-varying electric and magnetic fields. (3)
- 4 Derive the expression for the inductance of a co-axial cable. (3)
- 5 An EM wave in free space is incident normally on a dielectric with $\epsilon_r = 5$. Find the reflection and transmission coefficients. (3)
- 6 Write the differential equation for E-field of a uniform plane wave travelling in y-direction. Write also its solution in sinusoidal form. (3)
- 7 Define Standing wave ratio and explain the relation with reflection co-efficient of a transmission line. (3)
- 8 What is a quarter-wave transformer? (3)
- 9 Explain term wave impedance in a waveguide. Compare the wave impedance of TE and TM waves. (3)
- 10 Explain why TEM wave cannot propagate in a single conductor hollow waveguide. (3)

PART B

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

Module I

- 11 a) Given $\vec{D} = 2xy \vec{a}_x + x^2 \vec{a}_y$ c/m² in Cartesian co-ordinates. Verify Gauss divergence theorem for volume enclosed by $0 \leq x \leq 1, 0 \leq y \leq 2$ and $0 \leq z \leq 3$. (8)
- b) Derive Poisson's and Laplace's equations in electrostatics. (6)

OR

- 12 a) A point charge of 100 pc is located at origin and the plane $z = 5\text{m}$ also carries a charge of 5nc/m^2 . Find \vec{E} at point (1, 1, 1). (7)
- b) Given $W = x^2y^2 + xyz$. Compute ∇W and the directional derivative $\frac{dW}{dl}$ in the direction $3\vec{a}_x + 4\vec{a}_y + 12\vec{a}_z$ at (2,-1,0). (7)

Module II

- 13 a) Define magnetic scalar and vector potentials, stating the conditions under which each of them exist. (6)
- b) Derive the expression for energy stored in a charge distribution and hence in an electric field. (8)

OR

- 14 a) A cylindrical capacitor with $a = 1.5\text{ cm}$, and $b = 4\text{ cm}$ has an inhomogeneous dielectric of $\epsilon_r = \frac{10\epsilon_0}{r}$, where r is in cm. Calculate the capacitance per meter of the capacitor. (6)
- b) Derive the boundary conditions for electric field at the interface between two dissimilar dielectric materials, for zero and nonzero surface charge conditions.. (8)

Module III

- 15 a) Derive the expression for reflection and transmission coefficients when a uniform plane electromagnetic wave is incident obliquely on a dielectric surface with perpendicular polarization. (7)
- b) Show that electromagnetic waves gets attenuated very fast inside a good conductor medium. (7)

OR

- 16 a) Using wave equations in free space, show that the ratio of electric field intensity to magnetic field intensity is impedance and find its expression. (7)
- b) A 10GHz plane wave linearly polarized in x-direction and travelling in a free space in positive z-direction has amplitude, $E = 10\text{V/m}$. Find (7)
- a) Velocity of propagation c) wavelength
 Intrinsic impedance d) amplitude and direction of H-field.

Module IV

- 17 a) Derive the balancing equation for electromagnetic power flow density, from a closed surface. Distinguish the components of the power flow. (7)
- b) Calculate the Characteristic impedance, propagation constant and phase velocity at (7)

400KHz for a transmission line having $L = 0.5 \text{ mH/km}$, $C = 0.08 \mu\text{F/km}$ and negligible R and G.

OR

- 18 a) Derive the decoupled differential equations for voltage and current in a transmission line. Write the expressions for i) propagation constant and ii) the solutions for the differential equations. (8)
- b) A lossless transmission line has a characteristic impedance of 70Ω and a phase constant of 3 rad/m at 100MHz . Calculate the inductance/m and capacitance/m of the line. (6)

Module V

- 19 a) A $100 + j150\Omega$ load is connected to a 75Ω lossless transmission line. Using Smith chart, Find (i) Reflection coefficient at load (ii) VSWR (iii) Input impedance at 0.4λ from the load. (8)
- b) Explain the TE and TM modes in a rectangular waveguide. What is meant by the dominant mode? (6)

OR

- 20 a) From the equation for reflection coefficient, obtain the equation for the r -circles of the smith chart. (6)
- b) An air filled rectangular waveguide has dimensions of $a = 8\text{cm}$, $b = 4 \text{ cm}$. The signal frequency is 6 GHz . Calculate the following for dominant mode (TE mode). (8)
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|----------------------|--------------------------------------|
| a) Cut off frequency | c) phase constant and phase velocity |
| b) Guide wavelength | d) wave impedance |
