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Reg No.:_____ Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

B.Tech Degree S6 (R, S) / S4 (RT) (R, S) Examination May 2024 (2019 Scheme)

**Course Code: ECT302**

**Course Name: ELECTROMAGNETICS**

(Smith Chart should be supplied on request)

Max. Marks: 100 Duration: 3 Hours

**PART A**

***Answer all questions, each carries 3 marks.*** Marks

| | | |
|---|---|---|
| 1 | Convert the point A (2, -1,-3) to cylindrical coordinate system and spherical coordinate System. | (3) |
| 2 | Give the physical significance of Curl. | (3) |
| 3 | State the Maxwell's equation in integral form based on the following law - "Electromagnetic force induced in a circuit is equal to the rate of change of magnetic flux linking the circuit". | (3) |
| 4 | Define Magnetic Vector Potential and give relationship between Scalar and Magnetic Vector Potential | (3) |
| 5 | List the Maxwell's equations in differential form for time varying fields. | (3) |
| 6 | State Brewster's law. Calculate the Brewster angle for a quartz of dielectric constant 2.3 | (3) |
| 7 | Find the power of a wave with electric field intensity of 3 units in air. | (3) |
| 8 | Describe Linear, Circular and Elliptical Polarization. | (3) |
| 9 | Explain the terms 'Propagation constant' and 'Characteristic impedance' of a transmission line. | (3) |
| 10 | Describe how line section of a transmission line is used as circuit elements in high frequency applications. | (3) |

**PART B**

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

**Module I**

| | | | |
|---|---|---|---|
| 11 | a) | Explain Gauss Law and State Divergence theorem. | (6) |
| | b) | Find the total electric flux $\phi_E$ through the surface of a cube with side length a cantered at the origin considering the electric field E given by the expression $E = 2x^2\hat{a}_x + 3y\hat{a}_y - 4z\hat{a}_z$ | (8) |

**OR**

12 a) Derive the equation for Poisson's and Laplace equation. (6)

b) Determine whether the following potential fields satisfy Laplace equation (8)
(i) $V = x^2 - y^2 + z^2$
(ii) $V = \rho \cos \phi + z$

**Module II**

13 a) Derive the boundary conditions of static magnetic field at the interface of two different magnetic medium. (7)

b) Derive the expression for Capacitance of a Coaxial Cable (7)

**OR**

14 a) Derive the expression for equation of continuity. Describe how Ampere's law is modified by the equation of continuity. (10)

b) If the magnetic field intensity H in a region is, $(3y - z)\hat{a}_2 + 2x\hat{a}_y$, Find the current density at the origin. (4)

**Module III**

15 a) A lossy dielectric is characterised by $\varepsilon_g = 2 \cdot 5, \mu_g = 4$ and $\sigma = 10^{-3} \mho/m$ at 10MHz. Let $E_s = 20e^{-\gamma z} a_y$ V/m at z=0, Find the following parameters at $10^8$ Hz for a uniform plane wave (10)

(a) Attenuation constant

(b) Phase constant

(c) Velocity of propagation

(d) Wavelength

(e) Intrinsic impedance

(f) Magnetic field intensity $H_s$

(g) Electric field intensity E(x=2, y=3, z=4, t=10 ns )

b) Assume that a microwave oven operate at 2.45 GHz. Let $\sigma = 1.1 \times 10^6 \mho/m$ and $\mu_r = 600$ for the stainless steel interior, find the depth of penetration. (4)

**OR**

16 a) Derive the expression for reflection and transmission coefficients when a uniform plane electromagnetic wave is incident obliquely on a dielectric surface with parallel polarization. (8)

b) Assuming free space conditions derive wave equations for field E and H from Maxwell's equations. (6)

## Module IV

17 a) **Derive the expression of input impedance due to a transmission line terminated by a load $Z_L$** (7)

b) **Show that the power transferred through a given area in the field is determined by the combined influence of the electric and magnetic fields, integrated over a closed surface, indicating the flow of electromagnetic energy across that surface.** (7)

**OR**

18 a) Derive standard equation of two-wire transmission line. (7)

b) A plane-polarized electromagnetic wave $E = E_o \sin k(vt - z)a_x$, $H = H_o \sin k(vt - z)a_y$ travels in free space. (7)

(i) Show that Poynting's vector is given by $P = c\varepsilon_0 E_x^2$, where c is velocity of light in free space

(ii) Find the Average value of Poynting's vector $P_{av}$

(iii) Determine the expression for $E_0$

(iv) Find the expression for $H_0$

## Module V

19 a) Obtain the input impedances for open circuited and short-circuited transmission lines. How they relate to characteristic impedance of the line. (6)

b) A standard air-filled rectangular waveguide with dimensions a = 5 8.636 cm, b =5 4.318 cmi s fed by a 4 GHz carrier. Determine whether $TE_{10}$ mode and $TM_{11}$ mode will be propagated. If so, calculate the phase velocity and the group velocity for each mode. (8)

**OR**

20 a) The 0.1λ length transmission line has a characteristic impedance of 50Ω is terminated by load impedance of $Z_L = 5+j25\ \Omega$ . Using Smith Chart, determine (8)

(i) Impedance at 0.1λ

(ii) VSWR

(iii) Reflection Coefficient and Angle of reflection coefficient

b) What is meant by the dominant mode? Explain the TE and TM modes in a rectangular waveguide. (6)

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