Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Supplementary Examination May 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 Determine the curl of the vector function $\mathbf{F}= x^2y\ \mathbf{a}_x + xz\ \mathbf{a}_y + 2yz\ \mathbf{a}_z$. If G is a vector function equal to curl F. Also find divergence of G. (3)

2 State Gauss's law and obtain its point form. (3)

3 Calculate the capacitance of a coaxial cable 5m long which has a conductor at the centre with radius 2cm and a dielectric of $\varepsilon_r = 7$ for a thickness of 1cm. (3)

4 Given magnetic vector potential $A=10\ \text{Sin}\theta\ \mathbf{a}_\theta$ in spherical coordinate system, find the magnetic flux density at $(2,\pi/2,0)$ (3)

5 Define the depth of penetration of electromagnetic wave in a good conductor (3)

6 For a lossy dielectric medium $\mu_r = 1, \varepsilon_r = 48$, $\sigma = 20$ s/m. Calculate the loss tangent and intrinsic impedance at a frequency of 16GHz. (3)

7 What are line parameters of a transmission line? (3)

8 A telephone line has R=30Ω/km, L=100mH/km, G=0 and C =20μF/km at f = 1KHz Obtain a) Characteristic impedance of the line b)Propagation constant c)Phase Velocity (3)

9 A lossless 50Ω transmission line is terminated in a load with $Z_L = (50+j25)\ \Omega$. Calculate reflection coefficient and standing wave ratio (3)

10 Explain the term phase velocity and group velocity of waves in a waveguide (3)

PART B

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

Module I

11 a) Find the nature of the following fields by determining divergence and curl (7)

i) $\mathbf{F}_1 = 30\ \mathbf{a}_x + 2xy\ \mathbf{a}_y + 5xz^2\ \mathbf{a}_z$

ii) $\mathbf{F}_2 = 150/r^2\ \mathbf{a}_r + 10\ \mathbf{a}_\phi$

b) Derive the expression for electric filed intensity at a general point P due to an infinite straight line having charge density ρ_l C/m. (7)

OR

12 a) State and prove Ampere's law and obtain its differential form (7)

b) The electric flux density is given by $\mathbf{D} = (r/4)\ \mathbf{a}_r$ nC/m^2 in free space. Calculate (7)
i) Electric field intensity at r=0.25m ii)Total charge within the sphere of r=0.25m
iii) Total flux leaving the sphere r=0.35m

Module II

13 a) State and Explain Maxwell's equations for time varying fields in the integral and differential forms. (7)

b) Assuming free space conditions obtain the general wave equation for electric field. (7)

OR

14 a) Derive the expression for inductance of a two wire transmission line (7)

b) Derive the boundary conditions for electric field components that are tangential and normal at the interface between two dissimilar dielectric materials. (7)

Module III

15 a) A lossless dielectric medium has $\sigma = 0$ $\mu_r = 1$, and $\varepsilon_r = 4$. A uniform plane electromagnetic wave has magnetic field component expressed as $\mathbf{H} = -0.1\ \mathrm{Cos}(\omega t - z)\ \mathbf{a}_x + 0.5\ \mathrm{Sin}(\omega t - z)\ \mathbf{a}_y$ A/m. Find i) phase constant ii) angular velocity iii) the wave impedance and iv) the component of electric field intensity of the wave. (7)

b) Starting from wave equation, derive the expression for attenuation constant and phase constant for a uniform plane wave in a good conductor. (7)

OR

16 a) Derive the expression of reflection and transmission coefficients when a uniform plane wave propagating in positive *x*- direction is incident normally to the surface of perfect dielectric. (7)

b) i) Explain Snell's law of refraction ii)Find the skin depth at a frequency of 1.6MHz in aluminium where $\sigma = 38.2$ MS/m. Also find the propagation constant and wave velocity (7)

Module IV

17 a) State Poynting Theorem. Derive the expression for total electromagnetic power flowing out of a volume, where **E** and **H** are the time varying electric and magnetic field quantities on the surface enclosing the volume. (7)

b) Define and explain the following terms of a transmission line i) characteristic impedance ii) Impedance matching. (7)

OR

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

b) What is polarisation? What are different types of polarisations? (7)

Module V

19 a) In a rectangular waveguide for which a=1.5cm , b= 0.8cm $\sigma = 0$; $\mu = \mu_0$ and $\varepsilon = \varepsilon_0$ (7)

$H_x = 2 \text{ Sin } (\frac{\pi x}{a}) \text{ Cos} \frac{3\pi y}{b} \text{ Sin } (\pi \text{ x} 10^{11} \text{t} - \beta z)$ A/m

Determine

a)The mode of operation b)The cut-off frequency c)The phase constant d)The propagation constant

b) A 70 Ω lossless line has s=1.6 and $\theta_\gamma = 300^0$. If the line is 0.6λ, Using Smith Chart Obtain i) Reflection Coefficient ii) Load Impedance Z_L iii) Input Impedance Z_{in} (7)

OR

20 a) Derive expression for TE mode in rectangular wave guide. (7)

b) Derive the expression for r-circles and x-circles in Smith Chart (7)

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