Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech S6 (S,FE) (FT/WP/S4 PT) Examination December 2025 (2019 Scheme)

Course Code: ECT302

Course Name: ELCTROMAGNETICS

(Smith chart should be supplied on request)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1 A vector field is given by the following equation $A=(y \cos ax)\ a_x + (y+e^x)\ a_z$ (3)
Find the curl of A at the origin.

2 Give Poisson's and Laplace equation in electrostatics. Give application. (3)

3 Write the general wave equation for a lossless medium and explain each term. (3)

4 For Silver the conductivity is $\sigma = 3.1*10^6$ s/m. At what frequency will depth of penetration be 1mm. (3)

5 In free space, Expression of Electric field of a plane wave is given by (3)
$\mathbf{E} = 50 \cos (10^8 t - \beta x)\ \mathbf{a}_y$, Find intrinsic impedance and attenuation constant and phase constant.

6 Derive the relation between Reflection coefficient and Standing Wave Ratio (SWR). (3)

7 Draw the circuit of small section of transmission line of differential length and label the circuit parameters. (3)

8 The open circuit and closed circuit impedances measured at the input terminals of a lossless transmission line of length 1.5m, are –j54.6Ω and j103Ω respectively. Find Z_0 of the line. (3)

9 Sketch the input impedance offered by open circuited and short circuited transmission line. (3)

10 List all the modes which are supported in rectangular waveguides and why? (3)

PART B

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

Module I

11 a) Point charges -0.3 μC and 0.5 μC are located at (25,-30, 15) and (-10, 8,12) respectively. Find the electric field **E** (6)
(i) Origin

(ii) P (15, - 30, 5).

b) Given the potential $V=50(\frac{Sin\theta}{r^2})$ in free space: (8)

(i) Determine whether V satisfies Lapalce's equation.

(ii) Find total charge stored inside the spherical shell $1<r<2$.

OR

12 a) Define Electric field intensity. Derive the equation for Electric field intensity at a distance 'r' from a point charge of Q coulombs. (6)

b) Two parallel conducting Disc are separated by distance 5mmat z=0 and z=5mm. If, V = 0 at z = 0 and V = 100 V at z = 5mm.Find the charge densities on the Disc. (8)

Module II

13 a) Derive the expression of capacitance and inductance of a coaxial cable. (10)

b) Find the frequency at which conduction current density and displacement current density are equal in a medium with $\sigma = 2*10^4$s/m and ε_r=80. (4)

OR

14 a) Derive Maxwell's first and second equations from Fundamental laws. (6)

b) Derive the boundary conditions for electric field components that are tangential and normal at the interface between two dissimilar dielectric materials. (8)

Module III

15 a) Find the skin depth, δ at a frequency of 1.6 MHz in aluminium, where σ =38.2MS/m and $\mu_r = 1$. Also find the propagation constant, γ and the wave velocity v. (6)

b) Derive the expression for refraction and reflection coefficient of plane electromagnetic waves that undergoing oblique incidence with vertical polarization (considering boundary separation). (8)

OR

16 a) Derive Brewster angle. A parallel-polarized plane wave is incident from air onto a dielectric medium with ε_r=9 at the Brewster angle. What is the refraction angle? (7)

b) Derive the expression for refraction and reflection coefficient of an electromagnetic wave incident normally on the boundary between two different regions. (7)

Module IV

17 a) Derive an expression for net outward power flow associated with an electromagnetic wave, from a surface. (8)

b) An airline has characteristic impedance of 70Ω and phase constant of 3 rad /m at 100MHz.Calculate the inductance per meter and capacitance per meter of the line. (6)

OR

18 a) Derive the equation of input impedance of a transmission line terminated by a load. (7)

b) A transmission line operating at 500 MHz has Zo=50 Ω α=0.04 Np/m, β =1.5 rad/m. Find line parameters R,L,C and G. (7)

Module V

19 a) A 30m long lossless transmission line with Zo=50 Ω operating at 2MHz is terminated with load Z_L=60+j40 Ω. If u=0.6c on the line using Smith chart find (7)

i. Reflection coefficient

ii. VSWR

iii. Input impedance

b) Derive the expression for Transverse Electric (TE) mode of propagation in rectangular waveguide. (7)

OR

20 a) A 100 + j150 Ω load is connected to a 75 Ω lossless transmission line .Using smith chart , find (7)

i. Reflection coefficient

ii. VSWR

iii. Load admittance

iv. Input impedance at 0.4 λ from the load

b) A rectangular wave guide has a dimension of 3cm x 5cm, and is operating at a frequency of 10 GHz. Calculate the cutoff wavelength, cutoff frequency, guide wavelength, phase velocity and group velocity and the wave impedance for TE_{10} (Transverse Electric) mode. (7)

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