Reg No.:_____ Name:_____

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 $\varepsilon_r = 5$. Find the relection 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 $0 \le x \le 1, 0 \le y \le 2$ and $0 \le z \le 3$.	(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 $z = 5m$ 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 chargege distribution and hence in an electric field. (8)

OR

14 a) A cylindrical capacitor with a= 1.5 cm, and b=4 cm has an inhomogeneous dielectric of $\varepsilon_r = \frac{10\varepsilon_0}{r}$, where r is in cm. Calculate the capacitance per meter of the capacitor. (6)

b) Derive the boundary conditions for elecric 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 = 10V/m. Find (7)

a) Velocity of propagation
Intrinsic impedance
c) wavelength
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 $L = 0.5\,mH/km, C = 0.08\mu F/km$ 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) propogation 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 capcitance/m of the line. (6)

Module V

19 a) A $100 + j150\,\Omega$ load is connected to a $75\,\Omega$ 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 menat 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 = 8cm, b = 4 cm. The signal frequency is 6 GHz. Calculate the following for dominant mode (TE mode). (8)

a) Cut off frequency
b) Guide wavelength
c) phase constant and phase velocity
d) wave impedance

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