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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (R,S) / S2 (PT) (R,S) Examination June 2023 (2019 Scheme)

Course Code: EET204

Course Name: ELECTROMAGNETIC THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

1	Calculate the gradient of a scalar field, $V=4xz^2+3yz$ at (1,1,1)	3
2	Check whether the vector field $\mathbf{A}=2z\rho\sin\varphi\mathbf{a}_\rho+\rho z\cos\varphi\mathbf{a}_\varphi+\rho^2\sin\varphi\mathbf{a}_z$ is irrotational or not.	3
3	Using Gauss's law, derive the expression for electric field intensity due to a point charge	3
4	What is an electric dipole? Define dipole moment.	3
5	Calculate the magnetic field intensity at (0,1,0) if the entire z axis carries a current of 2A in the positive z direction.	3
6	Distinguish between displacement current density and conduction current density	3
7	A uniform plane wave in free space is given by $\mathbf{H}=0.1\cos(2\times10^8t-\beta x)\mathbf{a}_y$ A/m. Calculate the value of β.	3
8	Calculate the intrinsic impedance of a lossless dielectric if its relative permeability is 8 and relative permittivity is 2.	3
9	Define standing wave ratio of a transmission line	3
10	State the condition for a transmission line to be lossless. How does the propagation constant of a lossless line is related to the line parameters?	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11	a)	Transform the vector $\mathbf{E}=z\mathbf{a}_y$ to spherical coordinates	4
	b)	Verify divergence theorem for the vector field, $\mathbf{A}=\rho^2z\mathbf{a}_\rho+3\rho z\sin\varphi\mathbf{a}_\varphi+\rho\mathbf{a}_z$ in the region bounded by a cylinder defined by $0\le\rho\le3$, $0\le\varphi\le2\pi$, $0\le z\le4$.	10
12	a)	A point P in space is given by (2, 4, 7) in cartesian system of coordinates. What are the coordinates of P in cylindrical system?	4

b) Verify Stoke's theorem for the vector field, $\mathbf{F}=x^2y\mathbf{a}_x - y\mathbf{a}_y$ over the contour formed by rectangle with corners (0,0,0), (2,0,0), (2,1,0) and (0,1,0). 10

Module -2

13 a) A point charge of 50pC is located at (2,1,3) while the x-axis carries a charge of 2nC/m. The plane z=3 carries 10nC/m^2 charge. Calculate the electric field intensity at (2,2,2). 9

b) Derive the expression for capacitance of a coaxial cable 5

14 a) A point charge of 4nC is located at (-4,5,0) while the line x=1, z=1 carries uniform charge 3nC/m. If V=0V at origin, find V at point A (3,2,1). 9

b) Using Gauss's law, derive an expression for electric flux density due to a uniformly charged sphere 5

Module -3

15 a) Derive the expression for magnetic field intensity on the axis of a circular loop carrying current I. 10

b) Given the magnetic vector potential $\mathbf{A}=\frac{-\rho^2}{4}\boldsymbol{a_z}$ Wb/m, calculate the magnetic flux density at the point (3,4,0). 4

16 a) Derive the magneto-static boundary conditions at the interface between two different magnetic media. 10

b) Explain the modification required to make Ampere's circuital law consistent under a time varying field. 4

Module -4

17 a) Derive electromagnetic wave equations from Maxwell's equations 10

b) At 50MHz, a lossy dielectric material is characterized by permittivity, $\varepsilon=3.6\varepsilon_0$, and permeability $\mu=2.1\mu_0$ and conductivity, σ =0.08S/m. Compute propagation constant of the medium. 4

18 a) Verify Poynting's theorem for power flow in a coaxial cable 9

b) Given that $\mathbf{H}=0.5e^{-0.1x}\sin(2\pi\times10^6t-2x)\mathbf{a}_z$ A/m, calculate the following 5
(i)Attenuation constant (ii) Phase constant (iii) Angular frequency (iv) Direction of wave propagation (v) Time period

Module -5

19 a) Derive wave equations for a transmission line. 10

b) A lossless transmission line having characteristic impedance of 120Ω is 4

operating at angular frequency of 5×10^8 rad/s. If the wave velocity on the line is 2.4×10^8m/s, Calculate inductance and capacitance per metre length of the line

20 a) Define the following terms with reference to wave propagation over a transmission line 6

(i) Propagation constant (ii) intrinsic impedance (iii) voltage reflection coefficient

b) The characteristic impedance of a lossless transmission line operating at 80MHz is 72 Ω. If the inductance per metre length, L=0.5μH/m, find (i) capacitance per metre length (ii) velocity of wave propagation (iii) phase constant (iv) voltage reflection coefficient if the line is terminated with a load of 60Ω 8

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