Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R,S) (FT/WP) Examinations April 2026 (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	Write the expression for differential length, differential surface area, and differential volume in the spherical coordinate system.	(3)
2	Find the gradient of the scalar quantity $U = x^2y + xyz$	(3)
3	Derive Maxwell's equation in Integral form from Faradays Law.	(3)
4	Explain the concept of Magnetic Vector Potential	(3)
5	What is Skin Depth? Prove that skin depth is inversely proportional to the square root of the frequency of operation.	(3)
6	Explain the relationship between Brewster's angle and the reflection coefficient in connection with electromagnetic waves	(3)
7	Explain the four transmission line parameters.	(3)
8	A lossless transmission line with a characteristic impedance of 600 ohms is terminated with a resistance of 300 ohms. Calculate the voltage standing wave ratio in the line.	(3)
9	In waveguides, what is the term used for the mode that propagates with the lowest cut-off frequency? Briefly explain why this mode is important.	(3)
10	A 50Ω transmission line is terminated in a load with Z_L =(50+j25) Ω. Compute the normalized impedance to represent this Z_L on a Smith chart.	(3)

PART B

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

Module I

11	a)	Point charges 5nC and -2nC are located at (2, 0, 4) and (-3, 0, 5) respectively. Calculate the electric force on a 1nC charge located at (1,-3, 7) and the E at that point.	(7)

b) Show that the Electric flux density outside a uniformly charged sphere reduces exponentially with distance. (7)

OR

12 a) Compute Curl of $F = 2\widehat{a_r} + sin\varphi\widehat{a_\varphi} - 3\widehat{a_z}$ (7)

b) An electric field is given by E=10ya_x+10xa_yV/m. Find the potential V assuming V = 0 at the origin. (7)

Module II

13 a) Prove that the capacitance of a coaxial capacitor with radii a and b for inner and outer conductors respectively is given by the expression $C = \frac{2\pi\epsilon l}{ln\frac{b}{a}}$ (7)

b) Justify the statement "The tangential component of Electric field must be continuous across the two boundaries" using the boundary conditions of Maxwells equations. (7)

OR

14 a) Compute the magnetic field intensity inside the inner conductor of a coaxial cable with radii a and b for inner and outer conductors and a thickness t for the outer conductor. (7)

b) Prove that the energy stored in Magnetic field is given by the expression (7)

$$\frac{1}{2}\mu H^2$$

Module III

15 a) A 300MHz wave propagating through fresh water with $\mu_r = 1, \epsilon_r = 78$ has E_o = 0.1V/m. Assuming a lossless media, compute the phase constant, velocity of propagation, wavelength and intrinsic impedance of the media. (7)

b) Show that the value of phase constant in a lossy medium is given by the expression $\beta = \omega\sqrt{\frac{\mu\epsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega\epsilon}\right)^2}+1\right]}$ (7)

OR

16 a) Show that the electric field leads magnetic field by 45^0, when an electromagnetic wave propagates in a good conducting medium. (7)

b) Derive expressions for reflection coefficient and transmission coefficients for a plane electromagnetic wave at normal incident to a boundary. (7)

Module IV

17 a) Starting from Maxwell's equations, derive a relationship that describes the flow of electromagnetic energy in a specific volume of space. Explain the physical meaning of each term in the derived equation. (7)

b) What is polarization of electromagnetic waves? With figures, explain the different types of polarizations. (7)

OR

18 a) Prove that the input impedance of a transmission line with characteristic impedance Z_0 and terminated at Z_L is given by the expression $Z_{in} = Z_0[\frac{Z_L+jZ_0 tan\beta l}{Z_0+jZ_L tan\beta l}]$ (7)

b) A distortion less line has $Z_0 = 60\Omega$, $\alpha = 20$Np/m, u = 0.6c, where c is speed of light in vacuum. Find R, L, G, C and λ at 100MHz (7)

Module V

19 a) A 70 Ω lossless line has s=1. and $\theta\gamma = 300^0$. If the line is 0.6λ, Using the Smith Chart Obtain i) Reflection Coefficient ii) Load Impedance Z_L iii) Input Impedance Z_{in} (7)

b) A hollow rectangular waveguide has dimensions 6cm X 4cm, If a signal with frequency 5GHz is impressed, calculate a)cutoff frequency and b)cutoff wavelength assuming the dominant mode of propagation (7)

OR

20 a) A lossless transmission line with $Z_0 = 50\ \Omega$ is terminated at $Z_L = 60 + j40\ \Omega$. Compute reflection coefficient, standing wave ratio and load admittance using smith chart. (7)

b) A hollow rectangular waveguide has dimensions 6cm X 4cm, If a signal with frequency 5GHz is impressed, calculate a)cutoff frequency and b)cutoff wavelength assuming the lowest possible TM mode of propagation (7)

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