Total number of printed pages: **Programme (UG) 5th Semester/UECE501**

2022

Electromagnetic Waves

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1	(a)	Convert point T(0,-4,3) and S(-3,-4,-10) from Cartesian to cylindrical co-ordinates	6
	(b)	Transform vector $Q = \frac{\sqrt{x^2+y^2}a_x}{\sqrt{x^2+y^2+z^2}} - \frac{y^2 a_z}{\sqrt{x^2+y^2+z^2}}$ to cylindrical co-ordinate.	9
	(c)	Evaluate Q at T in the Cartesian and cylindrical coordinate systems.	5
2	(a)	Prove that the electric field at a point (r>a) due to a uniformly charged Sphere of radius a is the same as the whole charge is located at the centre of the sphere.	9
	(b)	A circular disk of radius a uniformly charged with $\rho_s\ C/m^2$. If the disk lies on the $Z = 0$ plane with its along the Z-axis, (i) Show that at point (0,0,h) $E = \frac{\rho_s}{2\varepsilon_0}\left\{1 - \frac{h}{\left[h^2 + a^2\right]^{1/2}}\right\}a_z$ (ii) From this, derive the E field due to an infinite sheet of charge on the $Z = 0$ plane. (iii) If $a \ll h$, show that E is similar to the field due to a point charge.	11
3	(a)	Derive the expressions of the electric and magnetic fields of an electromagnetic wave propagating in a lossy dielectric medium.	10
	(b)	Derive the expression of intrinsic impedance η and $\lvert\eta\rvert$ & θ_η	5
	(c)	What do you understand by the term loss tangent and what is its physical significance.	5
4	(a)	State and prove the Uniqueness theorem.	10
	(b)	Derive Poynting theorem and discuss the physical significance of each term in resulting equation	10
5	(a)	Establish the boundary conditions for electric and magnetic field intensities at the interference between two dielectric media.	8

	(b)	Explain how these conditions will be modified, if one of the media is a perfect conductor.	5
	(c)	If $X < 0$ defines region 1 and $X > 0$ defines region 2, then find the electric field intensity in region 2 ($\epsilon_{r1} = 5$), if electric field intensity in region 1($\epsilon_{r2} = 1$) is $\vec{E}_1 = (4\hat{u}_x + 1.5\hat{u}_y - 2\hat{u}_z)$ V/m.	7
6	(a)	Derive an expression for the input impedance Z_{in} of a lossless transmission line, in terms of relevant parameters, when the line is terminated into impedance Z_L.	10
	(b)	Show that for a lossless transmission line the input impedance of a line repeat over every λ/2 distance.	4
		At a frequency of 80 MHz, a lossless transmission line has a characteristic impedance of 300Ω and a wavelength of 2.5m. Find the value of L and C.	6
7	(a)	Derive the expressions for reflection co-efficient (г) and transmission coefficient (τ) when an electromagnetic wave incident from a medium characterized by $(\sigma_1, \mu_1, \epsilon_1, \eta_1)$ to a medium characterised by $(\sigma_2, \mu_2, \epsilon_2, \eta_2)$ normally at the boundary.	8
	(b)	What is VSWR? Derive its expression in terms of reflection co-efficient (г).	4
	(c)	Given a uniform plane wave in air as $E_i = 40Cos(\omega t - \beta z)a_x + 30Sin(\omega t - \beta z)a_y\ V/m$ (i) Find H_i (ii) If the wave encounters a perfectly conducting plate normal to the Z axis at Z=0, find the reflected wave E_r & H_r. (iii) What are the total E and H fields for $Z \leq 0$? (iv) Calculate the time –average Poyinting vector for $Z \leq 0\ and\ Z \geq 0$.	8