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

2023

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 P(1,3,5) from Cartesian to cylindrical co-ordinate	3
	(b)	Convert the vector A in Cartesian co-ordinate system $A = \rho z Sin\varphi a_\rho + 3\rho Cos\varphi a_\varphi + \rho Cos\varphi Sin\varphi a_z$	9
	(c)	What does divergence and curl mean and write their physical interpretation	4+4
2	(a)	Prove that the electric field due to an infinite sheet of charge along the normal direction does not depend on the distance (without using Gauss's divergence theorem)	8
	(b)	State Ampere's circuital law and write its expression in both integral and differential forms	4
	(c)	Establish the relation, $\nabla \times H = J + \delta D / \delta t$, where symbols have their usual meanings	4
	(d)	If $D = (2y^2 + z)a_x + 4xya_z + xa_z\ C/m^2$ find (i) The volume charge density at (-1,0,3) (ii) The flux through the cube defined by $0 \leq x, y, z \leq 1$ (iii) The total charge enclosed by the cube	4
3	(a)	State and explain Biot-Savart's law with necessary derivation	5
	(b)	State and explain Faraday's Law	4
	(c)	Derive the expression of the magnetic vector potential for line current, surface current and volume current	5
	(d)	Determine the Magnetic field intensity at a point P due to a current carrying filamentary conductor AB carrying current I along Z axis its upper and lower subtending angles α_2 and α_1 respectively.	6
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.	4
	(c)	A plane wave in a non-conducting medium has $E = 50Sin(10^8t + 2z)a_y V/m$. Find (i) The direction of propagation (ii) λ, f and ϵ_r (iii) H	8
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)	Find out the VSWR for the matched line and open circuited line	2
	(c)	A 30m long loss transmission line with $Z_0 = 50\Omega$ operating at 2MHz is terminated with a load $Z_L = (60 + j40)\Omega$. If $u = 0.6C$ on the line(C is the velocity of light in free space) find (without using Smith chart) (i) The reflection co-efficient (ii) the standing wave ratio (iii) the input impedance	8
7	(a)	Derive the expressions for reflection co-efficient (r) 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)	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 Poynting vector for $Z \leq 0$ and $Z \geq 0$.	8
	(c)	Explain the characteristics of Smith chart	4