Total number of printed pages: **Programme (UG) 6th Semester/UECE615A**

2023

Antennas and Wave Propagation

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1	(a)	Describe with necessary figure the radiation mechanism from a single wire.	5
	(b)	How does oscillating dipoles radiate?	5
	(c)	What are the different field regions surrounding a radiating antenna? Describe each of them.	6
	(d)	Show graphically how does the antenna amplitude pattern shape changes from reactive near field towards the far field?	4
2	(a)	What does beam area mean for a radiation pattern of an antenna?	4
	(b)	What are radiation intensity and radiation power density? Derive their relationship.	3+3
	(c)	What is the radiation resistance of the antenna? How does it varying with length of the antenna and frequency of operation.	3
	(d)	Derive the Friis transmission equation $\frac{P_r}{P_t} = e_{cdt}e_{cdr}(1-\lvert\Gamma_t\rvert^2)(1-\lvert\Gamma_r\rvert^2)\left(\frac{\lambda}{4\pi R}\right)^2 D_t(\theta_t,\varphi_t)\, D_r(\theta_r,\varphi_r)\lvert\widehat{\rho_t}.\widehat{\rho_r}\rvert^2$ Where the symbols have their usual meanings.	7
3	(a)	What are the different types of antenna polarization? Discuss each of them.	1+7
	(b)	Deduce the expression of magnetic vector potential due to current element of an infinitesimal dipole i.e Hertizian dipole. Also deduce the expressions for electric and magnetic fields.	4+4+4
4		Describe the expressions for the E and H fields in the far field zone of a short dipole $(\frac{\lambda}{50} \le l \le \frac{\lambda}{10})$ having current distribution $I(z') = I_o\left[1-\frac{2\lvert z'\rvert}{l}\right]\widehat{a_z}\,, \quad \left\{-\frac{l}{2} \le z' \le \frac{l}{2}\right\}$ Also derive the expression for the radiation resistance.	20

5	(a)	What is loop antenna? Why is it so important?	2+2
	(b)	Derive the expressions for far-field and radiation resistance of a square loop antenna.	16
6	(a)	For two element antenna array derive the expression for total radiated electric field. What is array factor?	6
	(b)	Deduce the expression of array factor for N element uniform array.	4
	(c)	For the two element antenna array, sketch the normalized field pattern when the currents are: (i) Fed in phase ($\beta = 0$), $d = \frac{\lambda}{2}$ (ii) Fed 90^0 out of phase$\left(\beta = \frac{\pi}{2}\right)$, $d = \frac{\lambda}{4}$	10
7	(a)	Define the broad side and end fire array of antenna.	4
	(b)	Deriving the necessary equations obtain the phase difference needed between the elements of an array to achieve broadside and end fire radiation pattern.	2+2
	(c)	Prove that to avoid grating lobes the maximum spacing between the array elements for broadside will be $d \leq \lambda$ and for end fire will be $d \leq \frac{\lambda}{2}$	5
	(d)	Prove that for large broadside array ($L \gg d$) the directivity of the array becomes$D_0 \approx \frac{2L}{\lambda}$.	7