Total No. of printed pages = 4

19/6th Sem/UECE 615 A

2022

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 the different types of radiation field patterns. 6

   (b) What does beam area mean for a radiation pattern of an antenna ? 2

   (c) Derive the expression of the directivity of an antenna in terms of beam area. 6

   (d) Calculate the directivity for the power pattern $P(\theta,\Phi) = P_0 \sin^2\theta \sin^3\Phi$, where $0 \le \theta,\Phi \le \pi$. 6

2. (a) What are the principle planes of a Radiation pattern ? Discuss each of them with suitable diagram. 6

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(b) With the suitable diagrams define the different types of lobes and beam width of an antenna radiation pattern. 6

(c) Define the bam efficiency and stray factor in an antenna radiation pattern. 3

(d) The normalized field pattern of an antenna is given by

$$E_n(\theta) = \frac{\sin(8\cos\theta)}{\sin(2\cos\theta)}, \text{ where } 0 \leq \theta, \leq \pi.$$

Find the angular position of nulls, and direction of maximum radiation. 5

3. (a) What does input impedance of an antenna mean ? 2

(b) Deducing the necessary equations show that power supplied by the generator to a radiating antenna is the summation of power radiation through radiation resistance, power dissipated as heat in loss resistance of the antenna and power dissipated in the internal resistance of the generator. 7

(c) What is the radiation of resistance of the antenna ? How does it varying with length of the antenna and frequency of operation ? 3

(d) Find the directivity, efficiency and effective area of an antenna if the radiation resistance and loss resistance of the antenna are 80Ω and 20Ω respectively. The power gain of the antenna is 13dB at the operating frequency 100 MHz. 8

4. (a) Define the radiation power density and radiation intensity. Derive their expressions and relationship. 2+3=5

(b) An antenna is fed with 100 watt power. The efficiency of the antenna is 80%. If the normalized power pattern is given by $P_n = \sin\theta\sin^2\Phi$, where $0 \le \theta, \Phi \le \pi$. 8

(c) Deriving the necessary formula find the effective length of half wave dipole antenna with effective area $A_e = 0.13\lambda^2$, radiation resistance $R_r = 73\Omega$, and input impedance $Z = 377\Omega$ operating at 100 MHz. 3+4=7

5. (a) What are auxiliary potential functions ? Why are they used to find the radiation fields ? 2+3=5

(b) Derive the expressions of radiation fields E and H using auxiliary functions. 15

6. (a) 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=12

(b) Derive the expressions for total power radiated from an infinitesimal dipole antenna and its radiation resistance. 4+4=8

7. (a) What are the advantages and disadvantages of microstrip patch antenna ? 4

(b) Describe the structure and radiation mechanism of a microstrip patch antenna with suitable diagram. 8

(c) Design a rectangular microstrip patch antenna using a substrate with dielectric constant of 2.4 and height 1.524 mm and resonating frequency at 8 GHz. 8