Assignment -1 Solutions

1. (b) Half power beamwidth in one plane (Lets say E-plane) $\theta_E = 60°$

Half power beamwidth in another plane (Lets say H-plane) $\theta_H = 70°$

$$\text{Directivity } D = \frac{41253}{\theta_E \theta_H}$$

$$D = \frac{41253}{60 \times 70}$$

$$D = 9.82$$

$$\text{Directivity in dBi} = 10 \log D$$

$$= 10 \log 9.82$$

$$= 9.9 \text{ dBi}$$

Directivity of antenna will be 9.9 dBi Ans(b)

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2. (d) All of the above. (d)

3. (d) Half power beamwidth in E plane $\theta_E = 72°$

Half power beamwidth in H plane $\theta_H = 2\pi = 360°$ because it is omni in other (H) plane.

$$\text{Directivity } D = \frac{41253}{\theta_E \theta_H}$$

$$D = \frac{41253}{72 \times 360}$$

$$D = 1.59$$

$$\text{Directivity in dBi} = 10 \log D$$

$$= 10 \log 1.59$$

$$= 2 \text{dBi}$$

Directivity of antenna will be 2dBi Answer(d)

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4. (b) Condition for circular polarization = equal amplitude and quadrature phase difference.

Answer is (b) Circular polarization

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5. (b) If HPBW of an antenna increases, its gain decreases (Answer is (b))

Common data:=

Percentage power reflected $P_r = |\Gamma|^2 P_{in}$

$$100 \times \frac{P_r}{P_{in}} = |\Gamma|^2$$

$$100 \times \frac{P_r}{P_{in}} = 20$$

$$\frac{P_r}{P_{in}} = 0.2 \Rightarrow |\Gamma|^2 = 0.2$$

$$|\Gamma| = \sqrt{0.2} = 0.45$$

6. (C)

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|} \Rightarrow \rho = \frac{1+0.45}{1-0.45} \Rightarrow \rho = 2.64$$

Approximate value of VSWR is 2.6 (C)

7. (a)

Input impedance $Z_{in} = \rho Z_0$ $\quad Z_0 = 50\Omega$

$$Z_{in} = 2.6 \times 50$$

$$Z_{in} = 130\Omega$$

Approximate input impedance of the antenna is 130Ω (a)

8. (9)

Gain $G_t = 12 dBi \Rightarrow 10 \log G_t = 12 \Rightarrow G_t = 10^{1.2} = 15.85$

$P_t = 20W$, distance $d = 80m$

Power density $P_d = \frac{P_t G_t}{4\pi r^2}$

$$P_d = \frac{20 \times 15.85}{4\pi (80)^2} = 3.94 \times 10^{-3} \text{ Watt/m}^2$$

$P_d \simeq 4$ milliwatt/m2

Answer is (a) 4 milliwatt/m2

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9. distance $d = 2\text{Km} \Rightarrow d = 2 \times 10^3 \text{ m} \Rightarrow r = 2 \times 10^3 \text{ m}$

(b) transmitted power $P_t = 25 \text{ dBm}$

$$10 \log_{10} P_t = 25$$

$$P_t = 10^{2.5} \Rightarrow P_t = 316.2 \text{ mWatt}$$

$$P_t = 0.316 \text{ Watt}$$

Received power $P_r = -65 \text{ dBm}$

$$10 \log \frac{P_r}{10^{-3}} = -65$$

$$P_r = 10^{-6.5} \times 10^{-3}$$

$$P_r = 3.16 \times 10^{-10}$$

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi r}\right)^2$$

$f = 10 \text{ GHz}$ $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{10 \times 10^9} = 0.03$ & $G_t = G_r = G$

$$\frac{P_r}{P_t} = G^2 \left(\frac{\lambda}{4\pi r}\right)^2 \Rightarrow G = \frac{4\pi r}{\lambda} \sqrt{\frac{P_r}{P_t}}$$

$G = 26.5$

Gain in dBi $= 10 \log G = 14.2 \text{ dBi}$

Approximate gain of antenna is 14 dBi (b)

10. Gain = 40dBi $\Rightarrow 10\log G = 40 \Rightarrow G = 10^4 \Rightarrow G = 10{,}000$

(C) $f = 8GHz$ $\quad \lambda = \frac{c}{f} = \frac{3\times10^8}{8\times10^9} = 0.0375$, $\eta = 0.7$

$$G = \eta \cdot 4\pi \frac{A_e}{\lambda^2} \qquad A_e = \frac{\pi d^2}{4}$$

$$G = \eta \cdot 4\pi \cdot \frac{\pi d^2}{4\lambda^2}$$

$$G = \eta \left(\frac{\pi d}{\lambda}\right)^2$$

$$d = \sqrt{\frac{G}{\eta}} \cdot \frac{\lambda}{\pi}$$

$$d = \sqrt{\frac{10000}{0.7}} \times \frac{0.0375}{\pi}$$

$$d = 1.43$$

diameter of parabolic dish antenna is 1.4m(C)