苏泓源 2019010448 天线 HW5

1.

a)

$\vec{S}_{av} = \frac{1}{2} Re[\vec{E} \times \vec{H}^*]$

$W_{rad} = \frac{1}{2} |E_\theta|^2 \cdot \sqrt{\frac{\varepsilon_0}{\mu_0}} = 3.3 \times 10^{-2} \, w/m^2$

b)

$P_{rad} = W_{rad} \cdot 4\pi r^2 = 4.2 \times 10^3 W$

1.2

a) $P_{rad} = P_{in} \cdot e = 113.1 \, mW$

$D = \frac{U_{max}}{P_{rad}/4\pi} = 22.22$

$D_{dB} = 10 \log D = 13.47 dB$

$G_{dB} = 10 \log G = 10 \log \frac{U_{max}}{P_{in}/4\pi} = 13.01 dB$

b)

$D_{dB} = 10 \log \frac{U_{max}}{P_{rad}/4\pi} = 13.01 dB$

$G_{dB} = 10 \log \frac{U_{max}}{P_{in}/4\pi} = 12.55 dB$

1.3

$U_{max} = 1$

$U_{av} = P_{rad}/4\pi = \int_0^{2\pi} \int_0^{\pi} U(\theta, \varphi) \sin\theta d\theta d\varphi / 4\pi$

$= 2\pi \cdot [1 - \cos(20^\circ) + \sin(20^\circ) \cdot 40^\circ] / 4\pi$

$= 0.15$

$D_{dB} = 10 \log \frac{U_{max}}{U_{av}} = 8.25 dB$

2.

2.1

$A_e = \frac{\lambda^2}{4\pi} \cdot G \quad \therefore G = \frac{U_{max}}{P_{in}/4\pi}$

$U_{max} = 1, \quad P_{in} = \int_0^{2\pi} \int_0^{\pi} U(\theta, \varphi) \sin\theta d\theta d\varphi$

$= 2\pi \cdot \frac{1}{5} = \frac{2}{5}\pi$

$\therefore A_e = \frac{(c/f)^2}{4\pi} \cdot 4\pi / \frac{2}{5}\pi = 7 \times 10^{-4} m^2$

2.2

a)

$A_e = \frac{\lambda^2}{4\pi} \cdot G = \frac{(c/f)^2}{4\pi} \cdot G = 3.2 \times 10^{-3} m^2$

b) $3.0 \times 10^{-3} m^2$

c) $2.94 \times 10^{-3} m^2$

3.

a)

linear

b)

linear

c)

circular, LHCP, AR=1, $\tau = \frac{\pi}{2}$

d)

circular, RHCP, AR=1, $\tau = \frac{\pi}{2}$

e)

elliptical, LHCP, $AR = 1+\sqrt{2}$, $\tau = \frac{\pi}{4}$

f)

elliptical, RHCP, $AR = 1+\sqrt{2}$, $\tau = \frac{\pi}{4}$

g)

elliptical, LHCP, AR = 2, $\tau = \frac{\pi}{2}$

h)

elliptical, RHCP, AR=2, $\tau = \frac{\pi}{2}$

4.

a)

$I = \frac{2}{99+67.5j} = 0.0138 - 0.094j$

$P_s = \frac{1}{2} Re(VI^*) = 0.0138W = 13.8mW$

b)

$P_r = \frac{1}{2} Re[I R_r I^*] = \frac{1}{2} \cdot |I|^2 \cdot Re[R_r]$

$= \frac{1}{2} \cdot (0.0167)^2 \cdot 73 = 10.18mW$

c)

$P_d = \frac{1}{2} Re[I R_d I^*] = \frac{1}{2} \cdot (0.0167)^2 \cdot 1$

$= 0.139mW.$