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HOMEWORK SET #2

Note: Please show all the steps leading to the final answer. Also, dB unit can be obtained by $A[dB] = 10\log_{10}(A)$.

1. An antenna with a radiation resistance of 65 Ω, a loss resistance of 5 Ω and a reactance of -75 Ω is connected to a generator with open-circuit voltage of 20 V (peak) and internal impedance of $Z_g = 60 + j10\Omega$ via a $\lambda/2$ long transmission line with characteristic impedance of 50 Ω (a) Draw the equivalent circuit
   (b) Determine the power supplied by the generator
   (c) Determine the power radiated by the antenna
   (d) Determine the power dissipated by the antenna

2. Repeat the previous problem assuming the transmission line is $\lambda/4$ in length.

3. A parabolic reflector antenna with a circular aperture of 5 m in diameter has a maximum effective area that is 75% of the physical area. The effective area was obtained assuming that PLF = -2.5 dB, $e_{cd} = 0.9$ and that the load is conjugate matched to the antenna. Determine the maximum directivity and gain of the antenna in dB when the frequency is $f = 18$ GHz.

4. The radiation intensity of an antenna can be approximated by (for $0 \le \phi \le 2\pi$)

$$U(\theta) = \begin{cases} \cos^3\theta & 0 \le \theta < \pi/2 \\ 0 & \pi/2 \le \theta < \pi \end{cases} \quad (1)$$

   Determine the maximum effective aperture (in m^2) of the antenna if its frequency of operation is $f = 12$ GHz. Assume that the antenna is lossless, PLF=-1.5 dB, the input impedance of the antenna is $Z_A = 55 + j15\Omega$ and that the antenna terminals are connected to a load of $Z_L = 50\Omega$.

5. An antenna has a far-zone radiation pattern at $f = 30$ MHz given by

$$\mathbf{E}_a = I_{in}\eta(\hat{\theta}25\sin\phi(1+\cos\theta) - j\hat{\phi}30\cos\phi(1+\cos^3\theta))\frac{e^{-jkr}}{r}, \quad (2)$$

   where I_{in} is the terminal current.
   (a) Determine the vector effective height $\mathbf{h}(\theta,\phi)$
   (b) Find the open circuit voltage for this antenna when it is in the receiving mode. Assume that the field incident (f=30 MHz) from the direction $\theta = \pi/3, \phi = \pi/4$ is a plane wave given by

$$\mathbf{H}^i = \hat{\theta}2 - j\hat{\phi} \quad \text{[A/m]}. \quad (3)$$

   (c) Find the effective area (in dB) for part (b). Assume that the antenna has an input impedance of $Z_A = 58 - j9\Omega$ and a load of $Z_L = 50\Omega$ connected directly to its terminals.