EC310 Homework 24 Solutions

2. a) Calculate the length, in meters, of a dipole antenna that is designed to receive a station at AM 800 on the dial of an AM radio.

For AM 800, the transmit frequency is 800 kHz, so wavelength is

\[ \lambda = \frac{c}{f} = \frac{3 \times 10^8}{800 \times 10^3} = 375 \text{ m} \]

For a dipole antenna, antenna length is \( \lambda/2 = 187.5 \text{ m} \)

b) Calculate the length, in meters, of a monopole antenna that is designed to receive the FM station at 107.1 MHz.

For FM 107.1, the transmit frequency is 107.1 MHz, so wavelength is

\[ \lambda = \frac{c}{f} = \frac{3 \times 10^8}{107.1 \times 10^6} = 2.8 \text{ m} \]

For a monopole antenna, antenna length is \( \lambda/4 = 0.7 \text{ m} \)

3. Given the following radiation pattern, where each ring represents a 1 dB change in power, what is the beamwidth? The sidelobe level? The front-to-back ratio?

Beamwidth = 40° as shown

\[
SLL_{dB} = G_{\text{mainlobe (dB)}} - G_{\text{sidelobe (dB)}}
\]

\[
= 0 \text{ dB} - (-5.5 \text{ dB}) = 5.5 \text{ dB}
\]

\[
FBR_{dB} = G_{\text{mainlobe (dB)}} - G_{\text{backlobe (dB)}}
\]

\[
= 0 \text{ dB} - (-5.5 \text{ dB}) = 5.5 \text{ dB}
\]

4. Given the following radiation pattern, where each ring represents a 2 dB change in power, what is the beamwidth? The sidelobe level? The front-to-back ratio?

Beamwidth = 90° as shown

\[
SLL_{dB} = G_{\text{mainlobe (dB)}} - G_{\text{sidelobe (dB)}}
\]

\[
= 0 \text{ dB} - (-7 \text{ dB}) = 7 \text{ dB}
\]

\[
FBR_{dB} = G_{\text{mainlobe (dB)}} - G_{\text{backlobe (dB)}}
\]

\[
= 0 \text{ dB} - (-10 \text{ dB}) = 10 \text{ dB}
\]
5. The power applied to an antenna with a gain of 4 dB is 13 W. What is the EIRP?

\[ EIRP = P_t \times G_t = 13 \text{ W} \times 10^{0.4} = 32.65 \text{ W} \]

6. What does it mean for an antenna to have directivity, and what are the advantages and disadvantages of a directional antenna?

Directivity means the antenna has the ability to focus transmitted power in a certain direction, rather than all directions like an isotropic antenna.

Advantages: Can transmit with less power for the same range, or can transmit a longer range with the same power. Can reduce interference problems with other transmitters at the same frequency. Can reduce likelihood of eavesdropping. Can reduce detectability of transmitting.

Disadvantages: With high gain, antennas can be very large. Also, harder to keep pointing at the receiver in a mobile situation.

8. The length of the driven element in a Yagi antenna is 900 mm; what is its operating frequency?

\[ \lambda / 2 = 0.9 \text{ m, so } \lambda = 1.8 \text{ m. } f = c / \lambda = 3 \times 10^8 / 1.8 = 166.67 \text{ MHz} \]

9. The mainlobe of an antenna has a maximum gain value of +18 dB at its peak point of forward direction. The same antenna has a gain of −5 dB at the peak point of its rear lobe. Determine the front-to-back ratio of the antenna.

\[ FBR_{\text{dB}} = G_{\text{mainlobe (dB)}} - G_{\text{backlobe (dB)}} = 18 \text{ dB} - (-5 \text{ dB}) = 23 \text{ dB} \]