



3

$$1. Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{12 \times 10^{-6}}{18 \times 10^{-12}}} = 816.5 \Omega$$

$$r = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{1200 - 816.5}{1200 + 816.5} = 0.19$$

$$S = \frac{1+r}{1-r} = \frac{1+0.19}{1-0.19} = 1.47$$

The greater the reflection coefficient is, the greater the standing wave ratio is. The higher these values are, the effectiveness of signal transmission decreases.

$$b. \lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.2 \times 10^9} = 0.25 \text{ m}$$

$$D_{TD} = \frac{2D^2}{\lambda} = \frac{2 \times (0.12)^2}{0.25} = 0.12 \text{ m}$$

Near field transmission areas are important for the antenna to be able to radiate in close distances. Far field regions are important for the antenna to be able to radiate across longer distances.

- c. Side lobes reduce an antenna's performance. Larger side lobes decrease the size of the main lobe, reducing the effectiveness of the antenna. Back lobes also reduce the performance of the main lobe, and can be caused by reflections. Overall, both side lobes and back lobes should be minimised in order to maximise the main lobe, and therefore the antenna's performance.

2. For the 1.5 GHz antenna:

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.5 \times 10^9} = 0.2 \text{ m}$$

$$L = \frac{\lambda}{2} = \frac{0.2}{2} = 0.1 \text{ m}$$

for the 0.9 GHz antenna

$$\lambda = \frac{3 \times 10^8}{0.9 \times 10^9} = 0.33 \text{ m}$$

$$L = \frac{0.33}{2} = 0.167 \text{ m}$$

It can be seen that increasing the length of a half-wave dipole antenna increases the wavelength of the antenna. In addition, this means that the operating frequency decreases when increasing the length of the antenna.

b. $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{180 \times 10^6} = 1.67 \text{ m}$

$$L = \frac{\lambda}{2} = \frac{1.67}{2} = 0.83 \text{ m} = \text{length of driven element.}$$

$$\text{Length of director} = 0.95 \times 0.83 = 0.79 \text{ m}$$

$$\text{Length of reflector} = 1.05 \times 0.83 = 0.875 \text{ m}$$

$$\text{Spacing between driven and reflector} = 0.15 \times 1.67 = 0.25 \text{ m}$$

$$\text{Spacing between driven and director} = 0.2 \times 1.67 = 0.33 \text{ m}$$

c.

$$S = \begin{bmatrix} 0 & S_{12} \\ S_{21} & 0 \end{bmatrix}$$

Q2 = (22)

3. $D = \frac{4\pi U}{P_{rad}} = \frac{4\pi \times 80}{100} = 10.05$

$$D_{db} = 10 \log_{10}(10.05) = 10.02 \text{ db}$$

b. If the network is reciprocal: $S_{12} = S_{21}$

$$S_{12} = 0.5 \angle -30^\circ$$

$$S_{21} = 0.5 \angle 30^\circ$$

$$\therefore S_{12} \neq S_{21}$$

$\therefore$ Network is NOT reciprocal

ii If network is lossless: $|S_{11}|^2 + |S_{21}|^2 + |S_{31}|^2 = 1$

$$0.4^2 + 0.5^2 + 0.7^2 = 0.9$$

$$0.9 \neq 1$$

$\therefore$ Network is NOT lossless

iii return loss = $-20 \log_{10} |S_{11}|$
 $= -20 \log_{10} 0.4 = 7.96 \text{ db}$

$$3c. \text{ii. } Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{2.5 \times 10^{-6}}{4.45 \times 10^{-12}}} = 749.5 \Omega$$

ii

$$\text{iii. } B = \omega \sqrt{LC}$$

$$\omega = 2\pi f = 2\pi \times 10 \times 10^6 = 6.3 \times 10^7$$

$$B = 6.3 \times 10^7 \times \sqrt{2.5 \times 10^{-6} \times 4.45 \times 10^{-12}} = 0.21$$

iv.

$$v = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.5 \times 10^{-6} \times 4.45 \times 10^{-12}}} = 3 \times 10^8 \text{ m/s}$$

Q3

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$$4. \bar{Z}_L = \frac{25 + j50\Omega}{50} = 0.5 + j1 \quad ?$$

$$ii. \lambda = \frac{c}{f} = \frac{3 \times 10^8}{140 \times 10^6} = 2.14m$$

$$iii. \frac{0.5 + j1}{50} = 0.01 + j0.02$$

$$iv. 0.177\lambda - 0.135\lambda = 0.042\lambda$$

$$0.042 \times 2.14 = 0.09m$$

$$v. 0.341\lambda - 0\lambda = 0.341\lambda$$

$$0.341 \times 2.14 = 0.731m$$

chd = (ii)

Q4 = 18

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SS

OS

