

1) A dipole antenna is designed to operate at a frequency of 100 MHz.

a) Calculate the length of the dipole antenna

b) Calculate the length of each half of the dipole.

Soln.

$$f = 100 \text{ MHz}$$

$$\lambda = \frac{c}{f}$$

$$\lambda = \frac{3 \times 10^8}{100 \times 10^6}$$

$$\lambda = 3 \text{ m}$$

$$a) L = \frac{\lambda}{2}$$

$$L = \frac{3}{2} = 1.5 \text{ m}$$

b) length of each half of the dipole.

$$L_1 = \frac{\lambda}{4} = \frac{3}{4} = 0.75 \text{ m}$$

2) A RADAR System transmits a signal of frequency 5 GHz. The system detects a moving target with a radial velocity of 1000 m/s. Calculate the doppler frequency shift.

Soln $f_t = 5 \text{ GHz}$

$$V = 1000 \text{ m/s}$$

$$f_{dp} = ?$$

We know,

$$V = \frac{\lambda f_{dp}}{2}$$

$$f_{dp} = \frac{2V}{\lambda}$$

also

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{5 \times 10^9}$$

$$\lambda = 0.06 \text{ m}$$

$$f_{dp} = \frac{2 \times 1000}{0.06}$$

$$f_{dp} = 33333.3$$

$$f_{dp} = 33.33 \text{ kHz}$$

3) A RADAR System transmits a Signal with a frequency of 2.6 GHz. The doppler Shift frequency has been Calculated as 21 kHz. Calculate the velocity of the target.

Soln

$$f_t = 2.6 \text{ GHz}$$

$$f_{dp} = 21 \text{ kHz}$$

$$V = \frac{\lambda f_{dp}}{2}$$

$$\lambda = \frac{c}{f}$$

$$= \frac{3 \times 10^8}{2.6 \times 10^9}$$

$$\lambda = 0.115 \text{ m}$$

$$V = \frac{0.115 \times 21 \times 10^3}{2}$$

$$V = 1211.5 \text{ m/s}$$

4) A RADAR System detects an Object at a distance of 1250m.
Calculate the time delay.

Soln ∴ $R = 1250 \text{ m}$

$$\Delta t = \frac{2R}{c}$$

$$= \frac{2 \times 1250}{3 \times 10^8}$$

$$= 8.3 \mu\text{s}$$

5) A continuous wave RADAR System measures a time delay of 5×10^{-6} sec. Calculate the distance to the target.

Soln.

$$\Delta t = 5 \times 10^{-6} \text{ sec.}$$

$$\Delta t = \frac{2R}{c}$$

$$R = \frac{\Delta t \cdot c}{2}$$

$$R = \frac{5 \times 10^{-6} \times 3 \times 10^8}{2}$$

$$R = 750 \text{ m}$$

6) A RADAR System operated at a frequency of 5 GHz and transmits a power of 150 kW. It has a transmitter antenna gain of 25 and receiver gain of 20. The RADAR detects a target with a Radar Cross Section of 8 m^2 at a slant range of 20 km. If the total loss is 1.5. Calculate the following

a) Wavelength of the RADAR Signal.

b) Power Received

Soln:

$$P_t = 150 \text{ kW}$$

$$G_t = 25$$

$$G_r = 20$$

$$L = 1.5$$

$$\sigma = 8 \text{ m}^2$$

$$R = 20 \text{ km}$$

$$f = 5 \text{ GHz}$$

a) wavelength.

$$\lambda = \frac{c}{f}$$
$$= \frac{3 \times 10^8}{5 \times 10^9}$$

$$\lambda = 0.06 \text{ m}$$

b) Power Received.

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4 L}$$

$$P_r = \frac{150 \times 10^3 \times 25 \times 20 \times (0.06)^2 \times 8}{(4\pi)^3 \times (20 \times 10^3)^4 \times 1.5}$$

$$P_r = 4.53 \times 10^{-15} \text{ W}$$