

1) 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

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

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

$$f_t, f_r, f_{dp}$$

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

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

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{5 \times 10^9}$$
$$\lambda = 0.06 \text{ m}$$

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

$$f_{dp} = 33333.33 \text{ Hz.}$$

$$f_{dp} = 33.33 \text{ KHz.}$$

2) A RADAR system transmits a signal with a frequency of 2.5 GHz.

The doppler shift has been calculated as 21 KHz. Calculate the velocity of the target.

~~Soln~~

$$f_t = 2.5 \text{ GHz.}$$

$$f_{dp} = 21 \text{ KHz.}$$

$$V =$$

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

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{2.5 \times 10^9}$$

$$\lambda = 0.12 \text{ m}$$

$$V = \frac{0.12 \times 2.1 \times 10^3}{2}$$

$$V = 1260 \text{ m/s}$$

3) A Continuous wave RADAR system operates with the speed of light. The RADAR measures a time delay of 5×10^{-6} seconds. Calculate the distance to the target.

Soln.

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

$$R = ?$$

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

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

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

4) A Radar System detect an object at a distance of 1250m. Calculate the time delay.

Soln.
 $\underline{\quad} \quad R = 1250 \text{ m}$

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

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

$$\Delta t = 8.3 \times 10^{-6} \text{ s}$$

5) A ground-based radar system is monitoring an approaching aerial target. The RADAR transmits a signal at 10GHz and the reflected signal from the target is received as 10.000005GHz .

Using the doppler effect, calculate the velocity of the target relative to the RADAR

Soln .

$$f_t = 10\text{GHz}$$

$$f_r = 10.000005\text{GHz}$$

$$v = ?$$

$$v = \frac{\lambda \cdot f_{dp}}{2}$$

$$f_{dp} = f_r - f_t$$

$$= 50000$$

$$f_{dp} = 50\text{kHz}$$

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

$$\lambda = 0.03 \text{ m.}$$

$$v = \frac{0.03 \times 500000}{2}$$

$$v = 750 \text{ m/s}$$