2.	**a.**	With CW transmitter of frequency 5 GHz, calculate the Doppler frequency seen by stationary radar when a target radial velocity is 100 Km/hr.	2	3	1	5

Set-1-2a

2a) Given,

$f_0 = 5GHz$ (transmitted frequency)

$f_d = ?$ (doppler frequency shift)

$V_r = 100km/hr$ (relative(or) radial velocity of target w.r.to radar

we know that

doppler frequency shift $(f_d) = \frac{2V_r}{\lambda}$

$$f_d = \frac{2V_r}{\left(\frac{c}{f_0}\right)} = \frac{2 V_r f_0}{c}$$

$$= \frac{2 \times 100 \times \frac{5}{18} \times 5 \times 10^9 \left(\cancel{m/s}\right)}{3 \times 10^8 \left(\cancel{m/s}\right)}$$

$$\boxed{f_d = 925.925Hz}$$

	b.	Consider an L-band radar with the following specifications: Operating frequency = 1000 MHz, BW = 3 MHz and Gain = 5000. Compute peak power, pulse width and minimum detectable signal for radar. Assume target RCS = $10m^2$, single pulse SNR = 15.4 dB, noise figure = 6 dB, noise temperature = 290 K, and maximum range = 200 KM	1	3	1	5

set-2

1(b) Given, frequency = 1000 MHZ

$BW = 3 MHZ$

$Gain = 5000$.

$RCS(\sigma) = 10 m^2$

Noise figure $(F_n) = 6 dB$

$SNR = 15 dB$

noise Temperature $(T_0) = 290 k$

max Range $(R_{max}) = 200 KM$

$10 \log F_n = 6$

$\log F_n = 0.6$

$F_n = 3.98$

$10 \log (SNR)_{min} = 15.4$

$\log (SNR)_{min} = 1.54$

$(S/N)_{min} = 34.67$.

a) pulse width $(\tau) = \frac{1}{BW} = \frac{1}{3\times10^6} = 3.33\times10^{-7} = 0.3 \mu s$

$\boxed{\tau = 0.3 \mu s}$

b) (S_{min}) minimum detectable signal for radar

$S_{min} = K T_0 B F_n (S/N)_{min}$

$= 1.38\times10^{-23} \times 290 \times 3\times10^6 \times 3.98 \times 34.67$

(where $k = 1.38\times10^{-23}$ Boltzmann constant)

$\boxed{S_{min} \quad 1.65\times10^{-12}}$

c) peak power (P_t)

$$P_t = \frac{R_{max}^4 (4\pi)^3 S_{min}}{G^2 \lambda^2 \sigma} \qquad \left(\because \lambda = \frac{c}{f}\right)$$

$c = 3\times10^8$ m/s

$$P_t = \frac{(200\times10^3)^4 \times (4\pi)^3 \times (1.65\times10^{-12})}{(5000)^2 \left(\frac{3\times10^8}{1000\times10^6}\right)^2 \times (10)}$$

$$P_t = \frac{16\times10^{20} \times 64\pi^3 \times 1.65\times10^{-12}}{25\times10^6 \times 9\times10^{-2} \times 10}$$

$$\boxed{\begin{aligned} P_t &= 232836.46\,W \\ P_t &= 0.23\,MW \end{aligned}}$$

b.	Determine the range and Doppler velocity of the target if target is moving away from FM-CW radar. The beat frequency observed for triangular modulation is f_{bu} = 50 KHz and f_{bd} = 20 KHz. Modulation frequency = 2MHz and Doppler shift = 2 KHz.	2	3	1	5

Set-2
26

Ans Let us Assume

frequency Sweep $(\Delta f) = 200\,KHZ$

& wavelength $(\lambda) = 3cm$.

Given,

$f_{bd} = 50\,KHZ$

$f_{bu} = 20\,KHZ$

$f_m = 2\,MHZ$ ($\because$ modulation frequency)

Rate of frequency change $(\dot{f}) = 2 f_m \Delta f$

$\dot{f} = 2 \times 2 \times 10^6 \times 2 \times 10^5$

$\dot{f} = 8 \times 10^{11}$

Range $(R) = \dfrac{c}{4\dot{f}} (f_{bu} + f_{bd})$

$= \dfrac{3 \times 10^8}{4 \times 8 \times 10^{11}} (20 + 50) \times 10^3$

$= \dfrac{3 \times 10^{11}}{32 \times 10^{11}} (70) = \dfrac{3}{32} \times 70$

$\boxed{R = 6.5625\,m = 0.006\,km}$

velocity of target (or) range rate (V_r)

$$V_r = \frac{\lambda}{4}(f_{bd} - f_{bu})$$

$$= \frac{3\times10^{-2}}{4}(50 - 20)\times10^{3}$$

$$= \frac{3}{4}\times30\times10$$

$$\boxed{V_r = 225 m/s}$$

	b.	Calculate the lowest blind speed of an MTI system operating at 3.6cm wavelength and transmitting at a pulse repetition time of 330µs.	3	3	1	5

Set-2

36) Given,

wavelength (λ) = 3.6 cm = 3.6×10^{-2} m

Pulse Repetition Time (PRT) = 330 μs

$$f_p = \frac{1}{PRT} = \frac{1}{330 \times 10^{-6}}$$

Blind Speed (V_B) = λf_p

$$= 3.6 \times 10^{-2} \times \frac{1}{330 \times 10^{-6}}$$

$$\boxed{V_B = 109.09 \text{ m/s}}$$