Chapter 1

12) $R_u = \frac{c}{2PRF}$

$dt = \tau \cdot PRF \Rightarrow PRF = \frac{dt}{\tau}$

$\therefore R_u = \frac{c}{2\cdot\left(\frac{dt}{\tau}\right)}$

$= \frac{299792458}{2\left(\frac{0.2}{1\times10^{-6}}\right)} \approx 750m = 0,75\,km$

14) $f_{d\,max} = \pm\frac{PRF}{2} = \pm\frac{\frac{1}{PRI}}{2} = \frac{\frac{1}{0,25\times10^{-3}}}{2} = 2\,kHz$

16) $\theta_3 = \frac{0.89\lambda}{a}$ radians

$\lambda = \frac{c}{f} = \frac{299792458}{2.8\times10^{9}} = 0.1\,m$

$\theta_3 = \frac{0.89\times0.1}{6,5} = 0.0137$ Radians

$\theta_3 = \frac{1,3\times0.1}{6,5} = 0,02$ radians - if the antenna is circular

$\therefore T = \frac{\theta_3}{\omega} = \frac{0.0137}{0.8} = 1.71\,ms$

or

$T = \frac{0.02}{0.8} = 2,5\,ms$

Chapter 2

2) $P_n = kT_oFB$

$= 1{,}38 \times 10^{-23} \times 290 \times 10^{\left(\frac{2{,}7}{10}\right)} \times 1 \times 10^{6}$

$P_{dbm} = 10 \cdot \log_{10}\left(\frac{P_n}{P_o\, mw}\right)$

$= -111{.}28$ dbm

a) $R_{det} = \left[\frac{P_t G_t G_r \lambda^2 \sigma n p}{(4\pi)^3 SNR\, kT_oFBL_s}\right]^{\frac{1}{4}}$

$50 \times 10^3 = \left[\frac{\overbrace{(P_t G_t G_r \lambda^2 n_p)}^{constant} \cdot 1}{\underbrace{(4\pi)^3 \cdot kT_oFBL_s}_{constant} \cdot SNR}\right]^{\frac{1}{4}}$

$50 \times 10^3 = \left[\frac{C \cdot 1}{SNR}\right]^{\frac{1}{4}} = \left[\frac{C \cdot 1}{10^{\left(\frac{18}{10}\right)}}\right]^{\frac{1}{4}}$

$\therefore C = \frac{R_{det}^4 \cdot SNR}{\sigma} = \frac{(50 \times 10^3)^4 \times 10^{\left(\frac{18}{10}\right)}}{1} = 3{,}94 \times 10^{20}$

a) $R_{det} = \left(\frac{3.94 \times 10^{20} \times 0{,}5}{10^{\left(\frac{18}{10}\right)}}\right)^{\frac{1}{4}} = 42{,}044$ km

b) $R_{det} = \left(\frac{3{,}94 \times 10^{20} \times 0.1}{10^{\left(\frac{18}{10}\right)}}\right)^{\frac{1}{4}} = 28.11$ km

14) $P_{rJ} = Q_r A_e = \frac{P_J G_J A_e}{(4\pi) R_{Jr}^2 L_s}$

$G_J(\text{linear}) = 10^{\frac{G_J db}{10}} = 10^{\frac{15}{10}} = 31.62$ 11)

$L_s(db) = 0.04 \times 100 = 4\ db$

$L_s(\text{linear}) = 10^{\frac{4}{10}} = 2.511\ W$

$P_{rJ} = \frac{100 \times 31.62 \cdot 1.2}{(4\pi)^2 \times (100 \times 10^3)^2 \times 2{,}511} = 1.2 \times 10^{-8}\ W$

$P_{rJ} = 10 \cdot \log_{10}\left(\frac{1.2 \times 10^{-8}}{1 \times 10^{-3}}\right) = -49{,}2\ dbm$

15) $JNR = \frac{P_{rJ}}{P_n} = P_{rJ}dbm - P_n dbm$
$= -49{,}2 - (-111{,}28) = 62.08\ db$

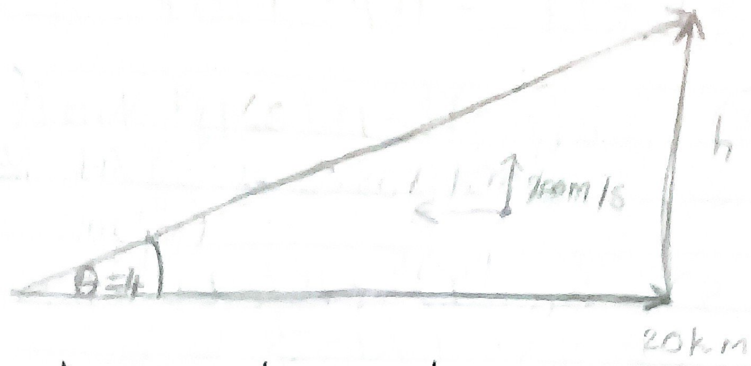
18) $P_{avg} A_E = SNR \times 4\pi k T_0 F L_s \frac{R^4}{\sigma} \cdot \frac{\Omega}{T_{fs}}$

$= 10^{\left(\frac{16}{10}\right)} \times 4\pi \times 1.38 \times 10^{-23} \cdot 290 \times 10^{\left(\frac{3.5}{10}\right)} \cdot 10^{\left(\frac{6.7}{10}\right)} \cdot \frac{(30 \times 10^3)^4}{0.1} \cdot \frac{\frac{\pi}{2} \times \cdot \frac{3\pi}{180}}{1{,}2}$

$= 9{,}245\ W \cdot m^2$

chapter 3

11)



$$h = 20 \cdot \tan(4^\circ) = 1{,}4 \text{ km}$$

$$t = \frac{1{,}4\text{km}}{200 \text{ m/s}} = 7s$$

to ensure atleast four detections opportunities the radars scan cycle must fit within this duration on four times, we divide t by 4 = 1.75s

$$\frac{7s}{4} = 1{,}75 \text{ s}$$

13) $P_D(2\text{-of-}3) = 3(0.5)^2 - 2(0.5)^3 = 50\%$

$$P_{fA} = 3(5\times10^{-3})^2 - 2(5\times10^{-3})^3 = 7{,}475\times10^{-3}\%$$

$$P_D(2\text{-of-}4) = 6(0{,}5)^2 - 8(0{,}5)^3 + 3(0{,}5)^4$$
$$= 0.6875$$

$$P_{fA}(2\text{-of-}4) = 6(5\times10^{-3})^2 - 8(5\times10^{-3})^3 + 3(5\times10^{-3})^4$$
$$= 1.49\times10^{-4}$$

1b) $P(3, 5) = 6P^5 - 15P^4 + 10P^3$

$P_D(3,5) = 6(0.9)^5 - 15(0.9)^4 + 10(0.9)^3$
$= 0.99144$

$P_{fA}(3, 5) = 6(0.01)^5 - 15(0.01)^4 + 10(0.01)^3$
$= 9{,}8506 \times 10^{-6}$

These results meet the requirements as $P_D(3,5)$ is $> 99\%$ and $P_{fA}(3,5)$ has been reduced.