1.

$f = 5.75 \times 10^9$;
$\lambda = 3 \times 10^8 / f \rightarrow 0.052\ m$

$Pfa = 10^{-10}$; $Pd = 0.98$
$prf = 1500$; $\omega rpm = 15$; $\theta B = 1.5$
$G = 10^{2.7}$

a)

Número de impulsos dentro de uma largura de feixe
*Number of pulses in a beam-width*

$$nB = \frac{\theta B\ prf}{6\ \omega rpm} \rightarrow 25$$

Número de impulsos integrados
*Number of pulses integrated*

$n = 10$

Fator de melhoria e eficiência do integrador
*Improvement factor and efficiency of the integrator*

$$I_i = \left(1 + 2 \sum_{k=1}^{(n-1)/2} e^{-5.55\, k^2 / nB^2}\right) \rightarrow 8.5$$

$E_i = I_i / n \rightarrow 0.85$

Relação SNR por impulso
*SNR per pulse*

$Pfa = 10^{-10}$; $Pd = 0.98$;
$A = Log[0.62 / Pfa]$; $B = Log[Pd / (1 - Pd)]$;
$SNR_1 = A + 0.12\, A\, B + 1.7\, B$

$\rightarrow$ SNR1=39.69 (16 dB)

Acresce 0.49 dB por se detetar um impulso retangular com um filtro gaussiano
*0.49 dB should be added because the rectangular pulses are detected with a Gaussian filter*

$SNR_1 dB \rightarrow SNR_1 dB + 0.49$ (16.48)

$SNR_1 = 10^{SNR_1\, dB/10} \rightarrow 44.4$

$Ta = 450$; $Ti = 1500$; $Teq = Ta + Ti \rightarrow 1950$

Largura de banda ótima
*Optimal bandwidth*

$\tau = 20 \times 10^{-6}$;
$\Delta f = 0.72 / \tau \rightarrow 36\ kHz$

Potência de ruído
*Noise power*

$Neq = 1.38 \times 10^{-23}\ Teq\ \Delta f \rightarrow 9.69 \times 10^{-16}$

$R = 75\,000\ m$; $\sigma = 10\ m^2$;

$$Pt = \frac{(4\pi)^3\ Neq\ SNR_1\ R^4}{\lambda^2\ G^2\ \sigma\ Ii} \rightarrow 46.5\ kW$$

**b)** primeiro há que encontrar a relação S/N de limiar, SNRT
First we have to find $SNR_T$ at threshold

$SNR_T$ = -Log(Pfa) → 23.03

$$PdSW3(SNR_1, SNR_T) = \left(1 + \frac{2\, SNR_1\, SNR_T}{(2 + SNR_1)^2}\right) e^{-\frac{2 SNR_T}{(2+SNR_1)}} \rightarrow 0.72$$

c)

$\tau = 20 \times 10^{-6}$;

dist = 50; $c = 3. \times 10^8$;

intervalo de tempo entre os máximos
*time interval between maxima*
$\Delta T = 2\, dist / c \rightarrow 3.33 \times 10^{-7}$

largura dos impulsos entre nulos,
*pulse width between nulls*
2/B; ΔT>2×2/B

$B = 4/\Delta T \rightarrow 1.2 \times 10^7$

$\mu = B/\tau \rightarrow 6 \times 10^{11}$ ( Hz/s )

$BMHz = B / 10^6$; $\tau\mu s = \tau \times 10^6$;
$\mu = BMHz / \tau\mu s \rightarrow 0.6$ MHz/μs

4.

$f = 6 \times 10^9$; $\lambda = 3 \times 10^8 / f$;

a)

HPBW = 2 °

a = 0.73 λ/HPBW (tabela/ *table*)

→ a=1.046 m; diam=2 a → 2.092m

$n = 2$; $\epsilon ab = \frac{2n + 1}{(n+1)^2}$ (* tabela/*table*: 0.55 *);

$$Gain = \left(\frac{2\pi a}{\lambda}\right)^2 \epsilon ab \rightarrow 9592\ (39.82\ dBi)$$

b)

ωrpm = 6; n_imp = 30;

$$prf = \frac{6\, \omega rpm\, n\_imp}{HPBW / °} \rightarrow 540$$

c)

d = 2.5m

$$\varphi = \frac{2\pi d}{\lambda} Sin(0.15°);$$

|Δ/Σ| =Tan(φ/2) → 0.436