ELE 4142

1) For the following RADAR system
x 3m target could be detected at
    I suggest you put this in a spre
    I suggest you do your calculati

$$S/N_{pulse} = RF \frac{\sigma}{R^4} \quad RF - \text{radar factor}$$

$$RF_{dB} = \text{power} + \text{ant } G - \text{Beam losses} + \text{Ant } G - \text{Beam losses} + \lambda + \sigma$$

$$-\frac{4\pi}{11} -\frac{4\pi}{11} -\frac{4\pi}{11} -k -T_N -BW -\text{losses}$$

RADAR SYSTEM PARAMETERS

Peak Power	61.46 dB	W
Antenna Aperture	5 m x <u>3 m</u>	
Pulsed Signal Frequency	2.8 GHz	
Pulse Width	600 ns	
Pulse Repetition Rate	1200 Hz	
Receiver Noise Bandwidth	61.7 dB	Hz
Effective Noise Temperature	29.5 dB	K
Typical system Losses	8 dB	
Antenna Rotation Rate	12 rpm	
Azimuth Beamwidth	1.3°	
Antenna beam forming losses	10 db	
S/N / dwell , min for detection	12 db	

$$= 61.46 + 42.1 -10 + 42.1 -10 + (-9.7) + (-9.7)$$

$$-11 -11 -(-228.6) -29.5 -61.7 -8$$

$$RF_{dB} = 202.55 dB$$

$$\sigma = 9.5 dB$$

$$S/N_{pulse} 1.3° \quad S/N - \text{pulse/dwell}$$

$$10 \underline{db} \quad 12 dB - 13.52 dB = -1.52 dB$$

$$R^4 = \frac{RF \cdot \sigma}{S/N_{pulse}} = 202.55 dB + 9.5 dB - (-1.52 dB)$$

$$= 213.6 \, dB$$

$$R = R^4/4 = 53 \, dB \text{ meters}$$

$$= 218902 \, m$$

$$= 219 \, km$$

2) Pipeline   60pts
The 4 stages of a data path have the following latencies
        Stage 1: 200ps, Stage 2: 400ps, Stage 3: 300ps, Stage 4: 100ps
Pipelining these stages adds 20% to the latency of each stage

a) Should you create a pipeline or not? (show your work)

<div align="center">

No Pipeline
Total time to execute an instruction is 1ns
1×10^9 instructions can be executed per second

Pipeline
Pipeline stages become
Stage 1: 240ps, Stage 2: 480ps, Stage 3: 360ps, Stage 4: 120ps
The longest time to complete a stage is 480ps
The clock cannot run faster than 1/480ps = 2.0833GHz
2.0833×10^9 instructions can be executed per second
Yes - Pipeline

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b) At what latency penalty (%) does your decision change? (show your work)

<div align="center">

Matching the no pipeline case
Max clock frequency = 1GHz
→ worst latency = 1ns
→ 400ns + 600ns → 150% pipeline latency penalty

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