Problem 1 | EE 417 | HW2

a) $B = 10MHz = 10^7 Hz \quad T = 300K$

$P_n = kTB = k \cdot 300 \cdot 10^7 = 1.38 \times 10^{-23} \cdot 30 \cdot 10^7$

$= 4.14 \times 10^{-14} = 10\log(4.14 \times 10^{-14}) = -133.8 dBW$

False, it is off by 25dBW.

b) False, co-channel interference is caused by a receiver picking up two signals from two transmitters.

c) True. FDMA stands for frequency division multiple access, and it ~~[illegible]~~ means every user uses a different band ~~[illegible]~~ forever.

d) True. Low frequencies are able to go around buildings/trees and other obstructions much better.

e) False. Transmit masks are real, but they are for transmission not going into other bands; they do not prevent listening on transmissions.

f) True. It allows cell providers to service very large areas by reusing frequencies from other cells.

g) True. Multipath is caused by reflections off surfaces, much like echoes are.

h) $B = 100 \times 10^3 Hz = 10^5 Hz \rightarrow 10^{-5}s = 10^4 ns \quad \frac{10^4 ns}{10^2 ns} = 100.$

True. The delay is 100 symbols apart, so it will be ISI.

i) $P_r \propto \frac{1}{d^p} \quad P_{r_1} = \frac{1}{1^2} = \frac{1}{1} \quad P_{r_2} = \frac{1}{2^2} = \frac{1}{4} \quad 10\log(4) = 6dB$

False. 2 is an underestimate for the exponent.

j)

False. Knowing variance does not help you determine the actual noise signal, n, so you could not just subtract it.

Problem 2 (p.1)	EE 417	Hw2

a) $d = 2\times10^{13}m$ $f = 8.4\times10^{9}Hz$ $B = 1000Hz$ $G_t = 30dBi$

$P_r = -170dBW \Rightarrow 10^{-17}W$ $P_t = 100W$ $p = 2$

$G_t = 10^3$

$\lambda = \frac{c}{f_c}$

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}$$

$$\frac{P_r (4\pi)^2 d^2}{P_t G_t \lambda^2} = G_r$$ B is negligible

$$\lambda = \frac{3\times10^8}{8.4\times10^9} = 3.57\times10^{-2}m$$

$$G_r = \frac{10^{-17}(4\pi)^2(2\times10^{13})^2}{(100)(10^3)(3.57\times10^{-2})^2} = \boxed{4.96\times10^9 = 97.0\ dBi \text{ or greater}}$$

1) build a high gain antenna.
2) transmit at a lower frequency
3) transmit at higher power

not really ground station changeable

4) like 1), build a larger antenna.
5) Have multiple antennae receiving.

b) $f = 1.6\times10^9 Hz$ $G_B = 10dB = 10$ $G_m = 3dB = 2$ $h_B = 30m$ $h_m = 1m$ $P_B = 10W$

$d = 1.2\times10^3 m$

$$P_r = P_t G_t G_r \frac{h_t^2 h_r^2}{d^4}$$

$$= (10W)(10)(2)\frac{(30m)^2(1m)^2}{(1.2\times10^3m)^4} = 8.68\times10^{-8}W = \boxed{-70.6dBW}$$

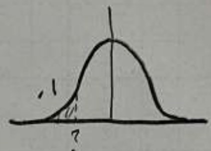
c)

Problem 2 (p.2)	EE 417	HW2

c) $L_s,\ \ell = 10\log(L_s) \sim N(0,100)$ $\sigma^2=100$ $\mu=0$

$L_s = e^{\ell/10}$

$-1.28 = z$



$\ell = z\sigma$

$L_s = e^{-1.28} \approx \underline{0.278}$

$= (-1.28)(10) = \underline{-12.8}$

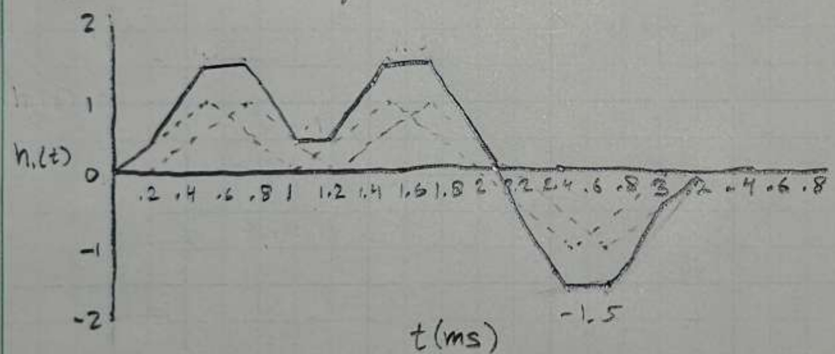
$$P_{rn} = P_t\, G_t\, G_r \frac{h_t^2 h_r^2}{d^4} L_s$$

$$= (10W)(10)(2)\frac{(30m)^2(1m)^2}{(1.2\times10^3 m)^4}(.278)$$

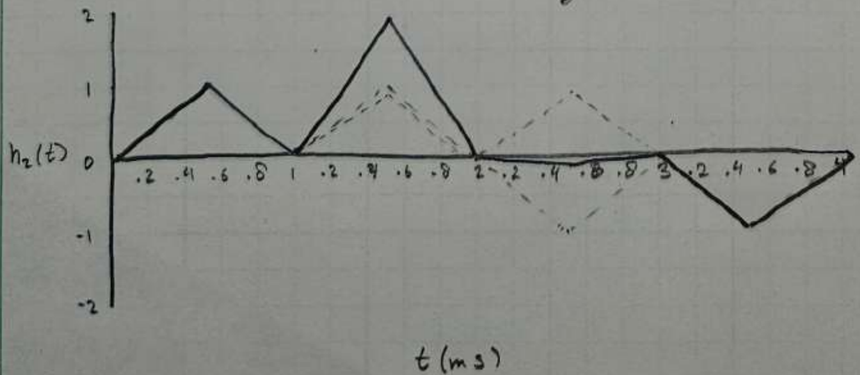
$$= 2.41\times10^{-8}\,W = \boxed{-76.17\,dBW}$$

d)

.2ms delay



1ms delay



h_1 is unresolvable (channel fading) but h_2 is resolvable (ISI).

Increasing power would be better. Increasing transmit time would cause channel fading.

Problem 2 (p.3)	EE 417	HW2

e) $f_c = 2.4\times10^9 Hz$ $\quad v = 50\frac{mi}{hr} = 22.4\ m/s$

$$f = f_c\left(\frac{c+22.4}{c}\right) = \boxed{2.400000168\times10^9 Hz}$$

Basically unchanged.

f)

$125m\cdot 2 = 250m \qquad \lambda = \frac{c}{f_c} = 0.125m$

$= 2000\lambda + 1\lambda \leftarrow$ pi shift

$= 2001\lambda$

out of phase, $\boxed{\text{destructive}}$

Move 0.125m, either forwards or backwards to get constructive interference.

Problem 3 | EE 417 | HW2

a) 88.0-108.0 MHz

b) 54.0-72.0, 76-88, 174-216, 470-608 MHz

c) 1.215-1.24 GHz, 1.559-1.61 GHz

d) 806-849 MHz, 851-894 MHz, 896-901 MHz,
929-930 MHz, 931-932 MHz, 935-941 MHz

e) 1.710-1.755 GHz, 1.755-1.85 GHz, 1.85-2 GHz

f) 2.39-2.4 GHz, 2.4-2.417 GHz, 2.417-2.45 GHz,
2.45-2.4835 GHz, 2.4235-2.5 GHz

g) 8.4-8.45 GHz, 8.45-8.5 GHz

h) 10.7-11.7 GHz, 11.7-12.2 GHz