FINAL 2005 PROB 1

Noise $= KTB = (1.38\times10^{-23}) \times (294) \times (0.1\times10^{6}\ Hz) = 4.06\times10^{-16}$

$N_{0dB} = 10\log_{10}(4.06\times10^{-16}) = -154\,dB$

$N_{dBm} = F + N_{0\,dB} + 30 = -117\,dBm$

Base Up (BASE RX, mobile TX)

Losses $= 0$

$G_{base} = 7 + 2.15 = 9.15\ dB$ — dBd; dipole

$SNR = 10\log_{10}(200) = 23\,dB$

$P_{min\ input\ base} = SNR - G_{base} + Loss + N_{dBm} = -103\,dBm$ — defines units

Mobile DN (Mobile TX, Base RX)

$P_{mobile} = 0.6W = 10\log_{10}(0.6) + 30 = 27.8\,dBm$ — convert to dBm

$Losses = -10\log_{10}(1-0.3) = 1.55\,dB$ Body

$-10\log_{10}(1-0.2^2) = 0.17\,dB$

Loss $= 1.7\,dB$

$G_{mobile} = 9\ dBi$

$P_{T\,eff} = P_{mobile\ base} + G_{mobile} - Loss = 35\ dBm$ — defines units

Path Loss

$PL = P_{min\ input} - P_{T\,eff} = \boxed{-138\ dB = PL}$ (b)

Mobile Up (Mobile RX, Base TX)

Losses

Gain

SNR

$P_{min\ in\ mobile} = SNR - Gain + Loss + Noise_{dBm} = -101\ dBm$ — defines units

Base DN (Mobile RX Base TX)

Losses, Gains, Same as Base Up (above)

$P_T = P_{min\ in\ mobile} - PL - G + L = 25.7\,dBm = 3.7\times10^{-1}W =$ (a) $\boxed{P_T = 28.7\,dB\mu}$ (add 30 to dBm)

defines units

(c) $10^{\frac{-13.8}{10}} = \left(\frac{\lambda}{4\pi d}\right)^2$ ← PL $\quad \lambda = \frac{c}{F} = \frac{3\times10^8}{1\times10^9} = 0.3\ m$ — given on board

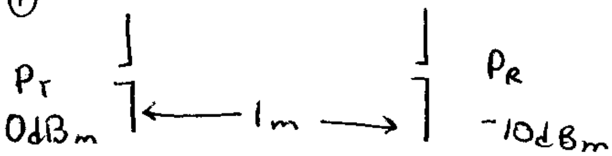
Will accept OR $PL = 10n\log d$

(5)

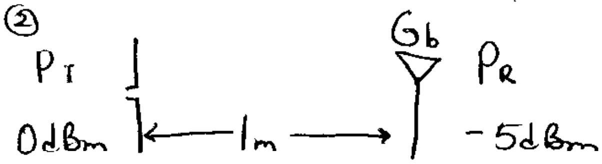
$d = \frac{\lambda}{4\pi}\frac{1}{(10^{-13.8})^{\frac{1}{2}}} = \boxed{19.2\,km = d}$ (c)

Final 2005 Problem 2

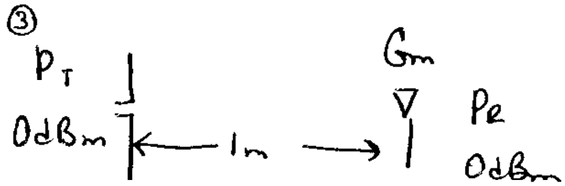
①



②



③



OR Using Equations

$$P_R = P_T + G_d + G_d - L$$

$$L = -[-10\,dBm + 0\,dBm - 2.15 - 2.15\,dB]$$

$$= +14.3\,dB$$

$$P_R = P_T + G_d + G_b - L$$

$$G_b = P_R - P_T - G_d + L$$

$$-5 - 0 - 2.15 + 14.3 = 7.15\,dBi$$

similarly

$$G_m = P_R - P_T - G_d + L$$

$$= 0 - 0 - 2.15 + 14.3 = 12.15\,dBi$$

Quick Way:

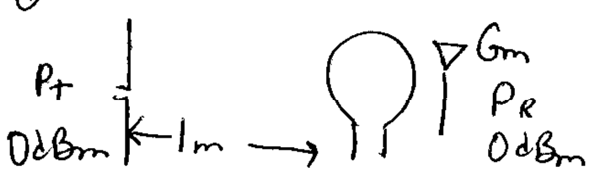
(a) Compare Measurements ① & ③

$$G_m = 10\,dBd = 10 + 2.15 = \boxed{12.15\,dBi = G_m}$$

(b) Compare measurements ① & ②

$$G_b = 5\,dBd = \boxed{7.15\,dBi = G_b}$$

④



$$L_{head} = 10\log_{10}(1 - .3)$$

$$= 1.55\,dB$$

$$P_R = P_T + G_d + G_m - L_{head} - L$$

$$G_m = P_R - P_T - G_d + L_{head} + L$$

$$= 0 - 0 - 2.15 + 1.55 + 14.3$$

$$\boxed{G_m = 13.7\,dBi}$$

Final 2005 Problem 3

Blocked calls dropped - Erlang B
GOS = .002

(10) (a) Use charts in front of exam, Table 3.4

	For 5 channels →	0.9 Erlang	x 4 =	3.6
	10	3.43	x 2 =	6.86
BEST	→ 20	10.1	x 1 =	$\boxed{10.1}$

(b) $H = 5\text{ min}\ \frac{1\text{ hr}}{60\text{ min}} = 0.083\text{ hr}$ call duration

$\lambda = 2$ calls/hr

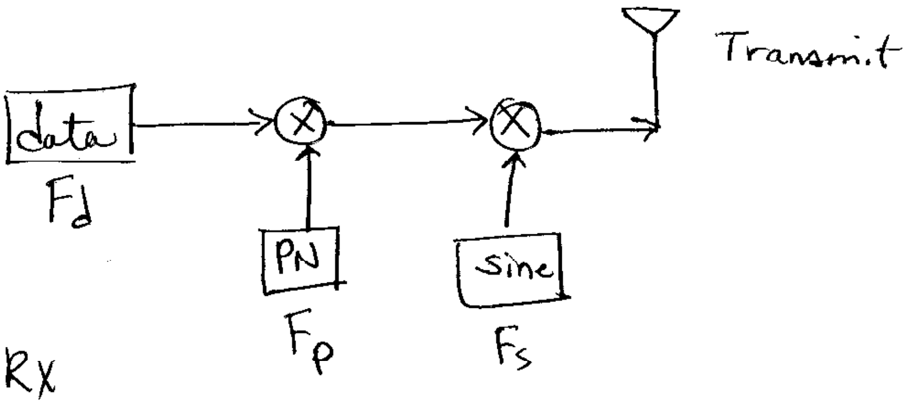
$A_u = \lambda H = 2\ \frac{5}{60} = 0.167$ Erlangs/user $= \frac{1}{6}$

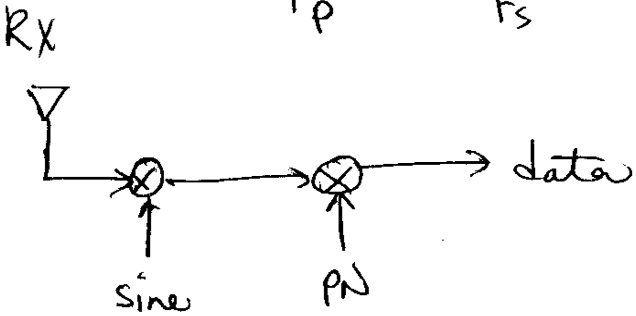
$\mu = \frac{A}{A_u} = \frac{10.1}{1/6} = 60$ users

Final 2005 Problem 4

(a)

5 pts

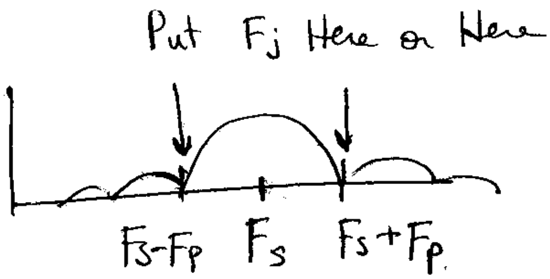




(b) 1 GHz jammer = F_j

20 points

data = 1 MHz = F_d



$F_j = F_s - F_p$ or $F_s + F_p$

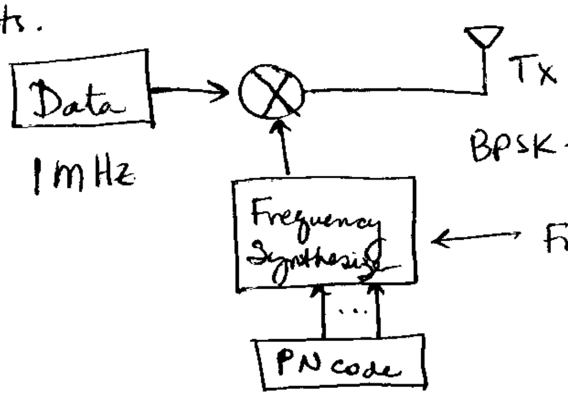
(any combination ok,

for example $F_s = 1.5$ GHz or 0.5 GHz

$F_p = 0.5$ GHz 0.5 GHz

Final 2005 Problem 5

(a) 5pts.

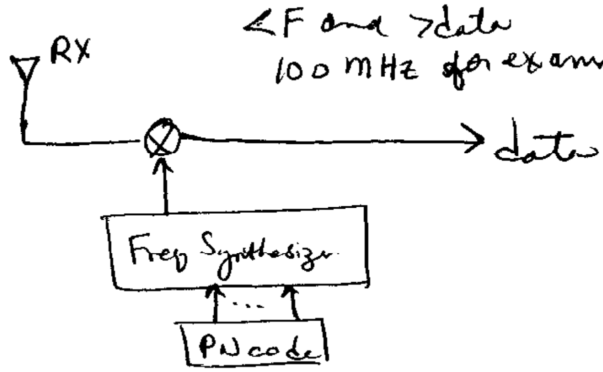


BPSK-ish with varying frequencies

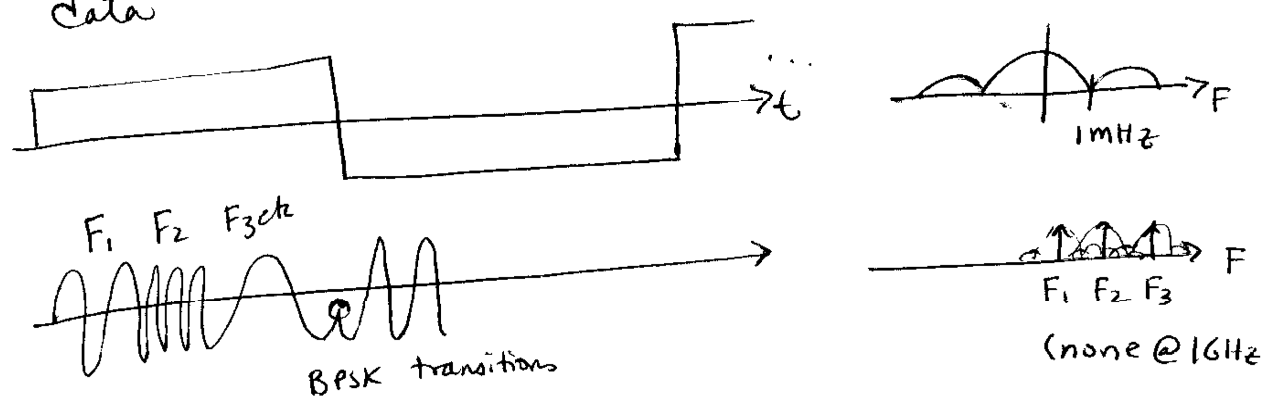
Frequency choices, anything except 1GHz. For example,

0.5, 0.75, 1.25, 1.5 GHz

<F and >data
100 MHz for example

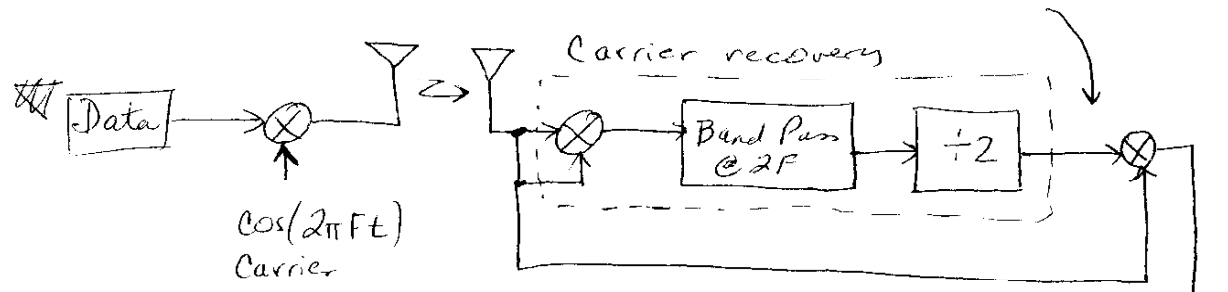


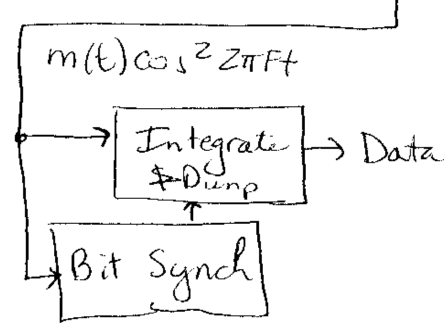
(b) data



Problem 6 Final 2005

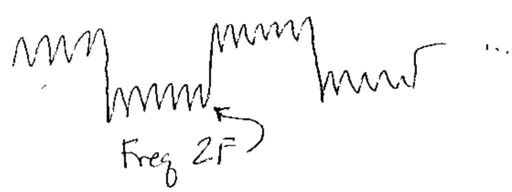
(a)

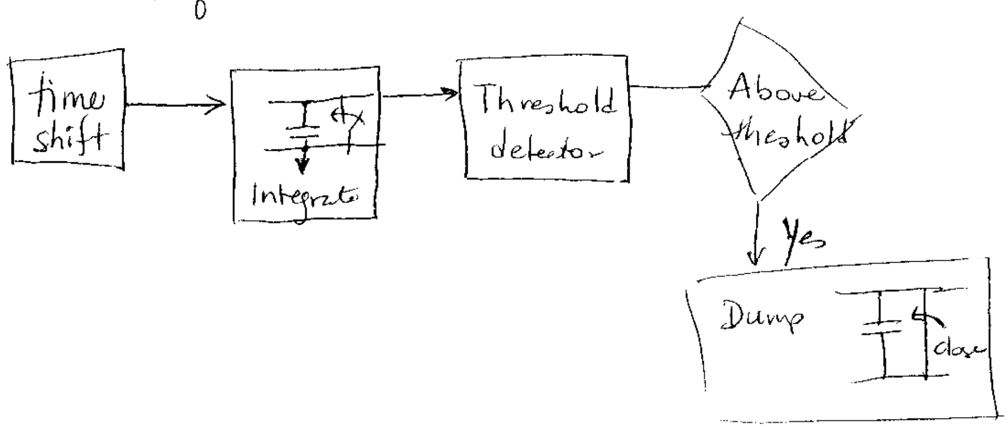




(b) Example of a bit synchronizer comes from your lab

$m(t)\cos^2 2\pi Ft$ looks like:





Final 2007 Problem 7

mobile power $P_m = 10\log_{10} 600\,mW = \quad dBm$

Chip rate $= R_c = B_w = 0.5\times10^6\ Hz$

data rate $R = 100\times10^3\ Hz$

cell loading $p = 0.50$

$L_p = (0 - 120 + 30) =$ loss @ 1m + Gant $= -90\,dBm$

↑ convert to dBm

$L_o = (0-20)$ loss @ 1m + Gant $= -20\,dB$

$\gamma = 3$ path loss exponent

From example 10.1

gain mobile $G_m = 4 + 2.15 = 6.15\ dBi$

" base $G_b = 8 \quad dBi$

Signal $S = p_m + G_m + G_b + L_p = -48\ dBm = 1.56\times10^{-5}\,mW$

$F = 2$ noise figure; 1.38×10^{-23} Boltzmann's constant

$N_0 B_w = \left(10^{F/10}\right) T k_b B_w \times 1000$ ← convert to mW

T: 290°K

$= 3.17\times10^{-12}\,mW = -115 \quad dBm$

$V_f = 0.2$ voice activity factor

$M = 20$ # users

$$E_b/I_t = \frac{R_c}{R}\,\frac{S_{linear}}{N_0 B_{w_{lin}} + (M-1)V_f S_{lin}} = 1.3158 = 1.2\,dB$$

must be > required

$\boxed{\text{No}}$ system will not work

Final 2005 Problem 8

$Q(.01) = 2.33$ From Chart

$\Delta = \dfrac{G_p}{E_b/I_t}(1-\eta) = 2.87$

$G_p = 16$ given

$E_b/I_t = 10^{7/10} = 5.0$ linear

$\eta = 0.10$ given

$\beta = 0.2322$ always

$\sigma_p = 10^{4/10} = 2.5$

$\alpha_c = e^{(\beta\sigma_p)^2/2} = 1.18$

$B = Q^2/\Delta = 1.89$

F of $10.35 = 0.17$

$f = 0.47$ from chart

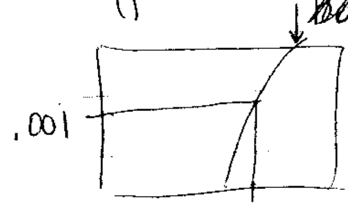
$V_f = 0.2$ given

$\dfrac{\lambda}{u} = \dfrac{\Delta F}{V_f(1+f)} = 1.67$ Erlangs

Erlang B: $\boxed{5 \text{ users}}$

~~Between~~, take lower #

About 5



$\dfrac{\lambda}{u} = 1.67$

Final 2005 Problem 9

(a) Interference Limited

Performance depends on interference level.

Interference is caused by transmitters in same cell + other cells.

Interference is > noise.

(b) Reduce BER

Use DSSS or FHSS, adjust to avoid/minimize known jammers

(c) Path Balance - why

Mobile may be RX ok from base, but not base from mobile. Calls dropped.

(d) Path Balance - how

- Compute effective radiated power from mobile (TX)
- Compute required input power for base (RX)
- Compute allowable path loss (PL)
- Compute required input power for mobile (RX)
- Compute effective radiated power for base (TX)

so that mobile receives exactly its required power + no more.

5 pts each