

ECE 146B Final Solutions

1. $x(t) = \sum b(n)p(t-nT_s)$

$$S_{xx}(f) = \frac{\sigma_b^2 |P(f)|^2}{T_s} + \frac{m_b^2}{T_s^2} \sum_k |P(\frac{k}{T_s})|^2 \delta(f - \frac{k}{T_s})$$

$m_b = 0, P(f) = T_s \text{sinc}(T_s f)$

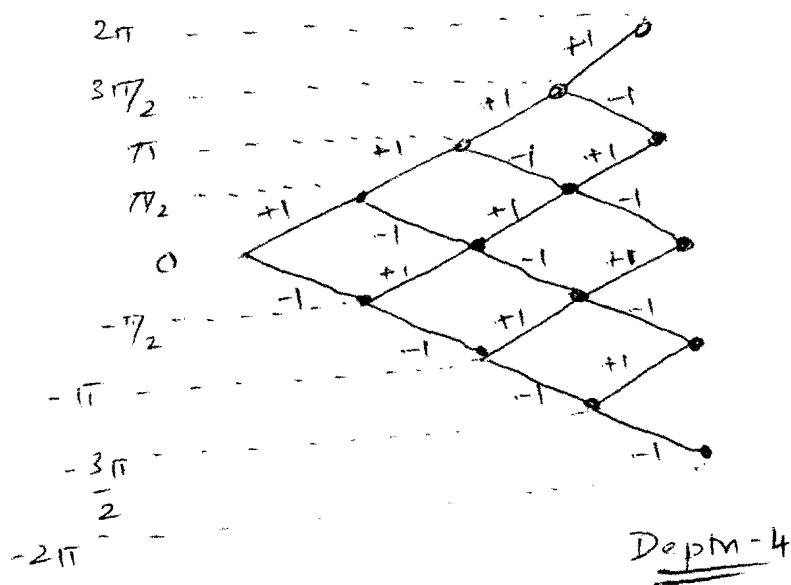
$S_{xx}(f) = \sigma_b^2 T_s \text{sinc}^2(T_s f)$

2. The transmitted phase of the

sequence $-1, -1, +1, -1, +1, +1, +1$

is:

$\Rightarrow -\pi/2, -\pi, -\pi/2, -\pi, -3\pi/2, -\pi, -\pi/2, 0$



$$3. \text{ let } \phi_1(t) = \sqrt{\frac{2}{T_b}} \cos 2\pi f_c t$$

$$\phi_2(t) = -\sqrt{\frac{2}{T_b}} \sin 2\pi f_c t$$

The waveforms are

$$s_1(t) = \frac{-3}{\sqrt{10}} \phi_1(t) + \frac{3}{\sqrt{10}} \phi_2(t)$$

$$s_2(t) = \frac{-1}{\sqrt{10}} \phi_1(t) + \frac{1}{\sqrt{10}} \phi_2(t)$$

$$s_3(t) = \frac{-3}{\sqrt{10}} \phi_1(t) - \frac{1}{\sqrt{10}} \phi_2(t)$$

$$s_4(t) = \frac{-1}{\sqrt{10}} \phi_1(t) - \frac{3}{\sqrt{10}} \phi_2(t)$$

$$s_5(t) = \frac{1}{\sqrt{10}} \phi_1(t) + \frac{3}{\sqrt{10}} \phi_2(t)$$

$$s_6(t) = \frac{3}{\sqrt{10}} \phi_1(t) + \frac{1}{\sqrt{10}} \phi_2(t)$$

$$s_7(t) = \frac{1}{\sqrt{10}} \phi_1(t) - \frac{1}{\sqrt{10}} \phi_2(t)$$

$$s_8(t) = \frac{3}{\sqrt{10}} \phi_1(t) - \frac{3}{\sqrt{10}} \phi_2(t)$$

4. For CDMA:

$$P(e)_k = Q \left(\frac{\frac{W}{B} \sqrt{E_k}}{\sqrt{N_0 \sum_{i \neq k} P_i}} \right)$$

P_i = Received power of i^{th} user

$\frac{N_0}{2}$ = Noise variance

E_k = Energy of k^{th} user.

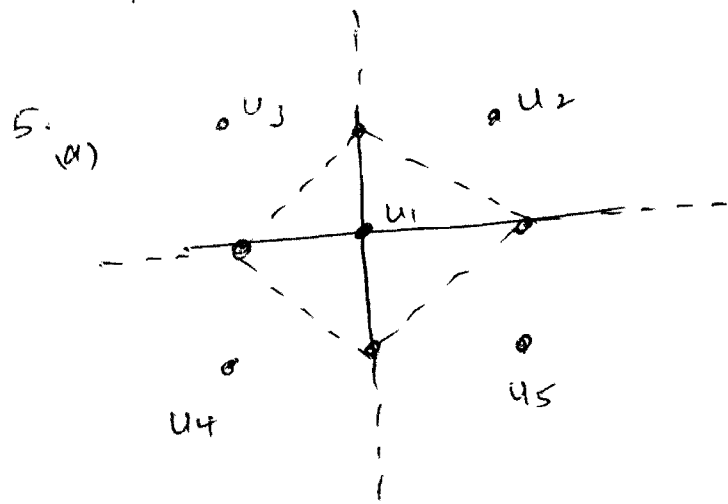
W = channel B.W.

B = Information rate.

(2)

The near far problem can be explained.

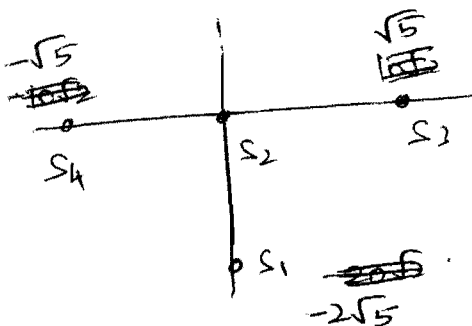
The other transmitters acts as noise (interference noise) to any device communicating with the base station. We see that if all devices transmit at same power, the ~~near~~ devices near to the base station jams the signals from the devices ~~far~~ which are far off. Hence, dynamic power control is required in CDMA systems to prevent cell breathing.



$$(b) E_{av} = \frac{1}{5} (0 + 4 \cdot 2 \cdot \frac{d^2}{4}) = \frac{2}{5} d^2$$

$$P_M \leq 4Q \left(\sqrt{\frac{3E_{av}}{(M-1)N_0}} \right) \leq \underline{\underline{4Q \left(\sqrt{\frac{3d^2}{10N_0}} \right)}}$$

6. (a)



~~STB~~

(b) Shifting Left or right \uparrow Ear
Shifting ~~down~~ ^{up} increases Ear.

Note: Equivalent \Rightarrow Same structure.
QPSK is not correct answer.

\therefore We have to shift ~~down~~ up.

The terms involving y in Ear are

$$p(y) = 3y^2 + (2\sqrt{5} - y)^2$$

$$\frac{d(p(y))}{dy} = 0 \quad \Rightarrow \quad 6y - 2(2\sqrt{5} - y) = 0$$

$$8y = 4\sqrt{5}$$

$$\boxed{y = \frac{\sqrt{5}}{2}}$$

$$7. \int_0^T \cos(2\pi f_c t + \phi_1) \cos(2\pi(f_c + m/T)t + \phi_2) dt$$

$$= \frac{1}{2} \int_0^T \cos\left(4\pi f_c t + \frac{2\pi m}{T} t + \phi_1 + \phi_2\right) dt$$

$$+ \frac{1}{2} \int_0^T \cos\left(\frac{2\pi m}{T} t + \phi_2 - \phi_1\right) dt$$

$$= \frac{1}{2} \left[\frac{\sin(2\pi m + \phi_2 - \phi_1)}{2\pi m/T} - \frac{\sin(\phi_2 - \phi_1)}{2\pi m/T} \right]$$

$$= \underline{\underline{0}}$$

$\therefore \cos(2\pi f_c t + \phi_1)$ and $\cos(2\pi(f_c + m/T)t + \phi_2)$ are \perp .