EE341 Spring 2003
April 23, 2003
Exam 2 Solutions

1) \( B_a = 70\text{KHz}, B_b = 440\text{KHz}, B_c = 150\text{KHz}, B_d = 320\text{KHz}, B_e = 640\text{KHz}. \)

2) \( p_1(t) = \sum_{k=-\infty}^{\infty} [\delta(t - kT)] \ast \Pi(20t/T) \) and \( p_2(t) = \sum_{k=-\infty}^{\infty} [\delta(t - kT/2 - T/4)] \ast \Pi(15t/T). \)

3) Let \( \phi(t) = 2\pi k_p m(t) \). Express signal first in quadrature representation as

\[
g(t) = (A + \alpha A \cos(\phi(t-\tau) - \phi(t) - \omega_0 \tau)) \cos(\omega_0 t + \phi(t)) - \alpha A \sin(\phi(t-\tau) - \phi(t) - \omega_0 \tau)) \sin(\omega_0 t + \phi(t))
\]

For PM we are interested in phase of \( y(t) \) which is given by

\[
\phi_y(t) = \phi(t) - \tan^{-1} \left( \frac{\alpha \sin(\phi(t-\tau) - \phi(t) - \omega_0 \tau)}{1 + \alpha \cos(\phi(t-\tau) - \phi(t) - \omega_0 \tau)} \right)
\]

When attenuation, \( \alpha \) is small we get that \( \tan^{-1}(x) \approx x \) and

\[
\phi_y(t) \approx 2\pi k_p m(t) + \alpha \sin(2\pi k_p (t - \tau) - 2k_p m(t) - \omega_0 \tau)
\]
4)

a) Sampling rate must be at least at the Nyquist rate which is twice the bandwidth of baseband signal, 30KHz.

b) Find minimum $l$ such that $90 < 10 \log(3 \times 4l/36)$. The smallest integer is $l = 17$.

c) Messages signals each have bandwidth $48 \times 15 = 816$KHz and cable can accommodate 61 signals.

5) MUX: $k=2/100/dt$; $ms1 = m1(1:k:K)$; $ms2 = m2(3:k:K)$; $ms3 = m3(5:k:K)$; $x=\text{zeros}(1,K)$; $x(1:k:K) = ms1$; $x(3:k:K) = ms2$; $x(5:k:K) = ms3$; 

DEMUX: $[n d] = \text{butter}(8.1/(2^k))$; $mp1 = \text{zeros}(1,K)$; $mp1(1:k:K) = x(1:k:K)$; $mh1 = \text{filter}(n,d,mp1)$; $mp2 = \text{zeros}(1,K)$; $mp2(3:k:K) = x(3:k:K)$; $mh2 = \text{filter}(n,d,mp2)$; $mp3 = \text{zeros}(1,K)$; $mp3(5:k:K) = x(5:k:K)$; $mh3 = \text{filter}(n,d,mp3)$;