EE341 Spring 2003
Exam 2
April 23, 2003
Closed Book, 2 crib sheets, Justify all work

Good Luck

NAME__________________________

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1) (25) Find the bandwidth of each of the signals $a(t)$, $b(t)$, $c(t)$, $d(t)$, and $e(t)$ below. Assume $l(t)$ and $m(t)$ are baseband signals with $B_l = 20000$Hz, $B_m = 15000$Hz, $|l(t)| \leq 100$, $|m(t)| \leq 200$, $|dl/dt| \leq 200$, and $|dm/dt| \leq 100$, $f_0 = 10^7$Hz, and $T = 1/32000$sec.

$$a(t) = l(t) + m(t) + (l(t) - m(t)) \cos(100, 000 \pi t + \pi /7)$$

$$b(t) = \cos(\omega_0 t + 500\pi \int_{-\infty}^{t} a(\tau) d\tau)$$

$$c(t) = (1000 + l(t)) \sin(\omega_0 t + 800\pi m(t))$$

$$d(t) = \sum_{k=-\infty}^{\infty} [m(t) \delta(t - kT)] * \Pi(10T/T)$$

$$e(t) = \sum_{k=-\infty}^{\infty} [m(t) \delta(t - kT)] * \Pi(20T/T) + \sum_{k=-\infty}^{\infty} [l(t) \delta(t - kT/2 - T/4)] * \Pi(15T/T)$$
2) (25) If possible, from problem (1) find the simplest system to recover \( m(t) \) and/or \( l(t) \) from each of the signals \( a(t), b(t), c(t), d(t), \) and \( e(t) \).
3) (15) Let $x(t) = A \cos(\omega_0 t + 2\pi k_p m(t))$ be a phase modulated signal. A PM receiver has as input $y(t) = x(t) + \alpha x(t - \tau)$ where $|\alpha| << 1$. The PM receiver consists of a bandpass limiter followed by an FM receiver followed by an integrator. Find the output of the PM receiver. Identify the dominant noise terms when recovering $m(t)$ from $y(t)$. Note that $y(t)$ consists of a PM signal plus a delayed and attenuated copy of the PM signal.
4) (17) We are given a high quality digital audio signal, \( m(t) \) which is a baseband signal with bandwidth 15KHz and power given by power \( V^2/36 \) where \( V \) is the maximum amplitude of signal.

a) At what rate must we sample \( m(t) \) to avoid aliasing.

b) If we use PCM encoding with a uniform quantizer with \( L = 2^L \) levels, what is the minimum number of bits \( l \) we need to encode \( m(t) \) to ensure a quantization error SNR of 90dB or greater.

c) Assume that we sample \( m(t) \) at \( 1/T = 48KHz \), what is the minimum bandwidth needed for this digital audio signal? How many digital audio signals can be accomodated by a cable that has bandwidth 50MHz?
5) (18) Write matlab code to time division multiplex three matlab signals: $m_1, m_2,$ and $m_3$. Each of the three signals has bandwidth $100Hz$, the time index is given by $dt = .001$, and the length of each baseband signal is $K$. The matlab commands should include both a multiplexor (transmitter) and a demultiplexor (receiver).