Name: ________________________ **Student Number:** ____________________

EE 132A Final

Winter 2008

Inst: Dr. C.W. Walker

Problem	Points	Score
1	20	
2	20	
3	20	
4	20	
5	25	
6	20	
7	15	
8	20	
9	20	
10	20	
Total	200	

Instructions and Information:

1) Print your name and student number at the top of the page.

2) Make sure your exam has 10 problems. Do not write any work to be graded on the back of the pages. There is extra workspace at the back of the exam.

3) This is a closed book exam. You may use two sheets of notes (front and back). You may also use a calculator.

4) Partial credit will be given but you must **show your work where appropriate or justify your answers to receive any credit.**

5) **Circle or box your final answers or points will be deducted.**

Problem 1. Compute the Fourier transform of the following (simplify your answers):

a. $x_1(t) = t\text{sinc}(t)$.

b. $x_2(t) = \bigwedge(2t - 2)$.

Problem 2. A SSB AM signal is generated by modulating a 500-kHz carrier by the message signal

$$m(t) = \cos(1000\pi t) + 4\sin(1000\pi t).$$

The amplitude of the carrier is $A_c = 200$.

a. Determine the signal $\hat{m}(t)$.

b. Determine the time domain expression for the lower sideband of the SSB AM signal. Simplify your answer as much as possible.

Problem 3. A FM modulated signal has the form

$$x(t) = 50\cos(2\pi f_c t + 2\sin 2000\pi t)$$

where $f_c = 20$ MHz.

a. Determine the average transmitted power.

b. Determine the peak-frequency deviation.

Problem 4. Let the random process $X(t)$ be defined by

$$X(t) = [A + ABe^{-t} + Be^{-t^2}]u(t)$$

where A, B are independent and identically distributed random variables each normally (Gaussian) distributed with mean 0 and variance of 1 and $u(t)$ is the unit step function.

a. Compute $m_X(t)$.

b. Compute $R_X(t_1, t_2)$.

Problem 5. A random process $Z(t)$ takes values 0 and 1. A transition from 0 to 1 or from 1 to 0 occurs randomly and the probability of having n transitions in an interval of length τ ($\tau \geq 1$) is given by

$$p_N(n) = (2\tau - 1)\left(\frac{1}{2\tau}\right)^{n+1}.$$

At $t = 0$, $Z(0)$ is equally likely to be a 0 or 1.

a. Find the mean function $m_Z(t)$ for $t \geq 1$.

b. Find the correlation $R_Z(t + \tau, t)$ for $t \geq 1$. Is $Z(t)$ stationary?

Problem 5 extra workspace.

Problem 6. In a certain communication system the transmitter power is 50 KW, the channel attenuation is 90 dB, and the noise power spectral density is 10^{-10} W/Hz. The message signal has a bandwidth of 10^4 Hz.

a. Find the predetection SNR in the received signal where the received signal is the transmitted signal plus the additve white Gaussian noise.

b. Find the output SNR if the modulation is conventional AM with a modulation index of 0.85 and a normalized message power of 0.3.

Problem 6 extra workspace.

Problem 7. Suppose that two signal waveforms $s_1(t)$ and $s_2(t)$ are orthogonal over the interval (0,T). A sample function $n(t)$ of a zero-mean, white noise process is cross-correlated with $s_1(t)$ and $s_2(t)$ to yield

$$n_1 = \int_0^T s_1(t)n(t)dt,$$

$$n_2 = \int_0^T s_2(t)n(t)dt.$$

Prove that $E[n_1 n_2] = 0$.

Problem 8. The received signal in a binary communication system that employs antipodal signals is

$$r(t) = s(t) + n(t)$$

where $n(t)$ is AWGN with power spectral density $N_0/2$ W/Hz and $s(t)$ has the value A in the interval 0 to 1 and in the interval 2 to 3.

a. Determine the variance at the output of the matched filter.

b. Determine the probability of error as a function of A and N_0 assuming equiprobable signals.

Problem 8 extra workspace.

Problem 9. A binary PAM communication system employs rectangular pulses of duration T_b and amplitudes $\pm A$ to transmit digital information at a rate $R = 10^4$ bits/sec. If the power spectral density of the additive Gaussian noise is $N_0/2$, where $N_0 = 10^{-3}$ W/Hz, determine the value of A that is required to achieve an error probability of $P_2 = 10^{-6}$.

Problem 10. In a certain (hypothetical) communication system we find the received signal at the input to a signal detector is

$$r = \pm A + n$$

where $+A$ and $-A$ occur with equal probability and the noise variable n has probability density function

$$p(n) = \begin{cases} n+1, & -1 \le n \le 0, \\ n-1, & 0 < n \le 1. \end{cases}$$

a. Determine the smallest value of A that yields a probability of error of 10^{-3}.

b. What is the smallest value of A that would guarantee error free communication, i.e., the probability of error is 0.

Problem 10 extra workspace.

Extra workspace. If you use this space for work to be graded reference it from the given problem.

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