Name: _____   **Student Number:** _____

Name of student to your left: _____

Name of student to your right: _____

EE 132A Midterm
Winter 2008

Inst: Dr. C.W. Walker

Problem	Points	Score
1	12	
2	12	
3	16	
4	16	
5	14	
6	14	
7	16	
Total	**100**	

Instructions and Information:

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

2) Make sure your exam has 7 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 one sheet 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.**

Problem 1. Compute the power in the following deterministic signals (note a power $\to \infty$ is possible):

a. $x_1(t) = A \cos(2\pi f_0 t + \theta)$.

b. $x_2(t) = t^{-1/4} \, u(t)$.

Problem 2. Compute the Fourier transform of the following (simplify your answers):

a. $x_1(t) = \Pi(t - 1/2) + \Pi(t + 1/2)$.

b. $x_2(t) = \Lambda(2t - 4)$.

Problem 3. A DSB-modulated signal

$$x(t) = Am(t)\cos(2\pi f_c t)$$

is mixed (multiplied) with a local carrier

$$x_L(t) = \cos(2\pi f_c t + \theta)$$

and the output is passed through a LPF with bandwidth equal to the bandwidth of the message $m(t)$. The signal power at the output of the LPF is denoted P_{out}. The modulated signal power is denoted P_X.

a. Compute $\dfrac{P_{out}}{P_X}$.

b. Now suppose we add noise to $x(t)$ so that before the mixing operation we have

$$x(t) = Am(t)\cos(2\pi f_c t) + n(t)$$

where $n(t)$ represents bandpass filtered white Gaussian noise centered at $\pm f_c$ with spectral height $\frac{N_0}{2}$ and bandwidth B. After mixing and passing through the LPF we get an output consisting of signal and noise components. Define the SNR_{out} at the output as the power in the signal component divided by the power in the noise component. Similarly, define SNR_{in} at the input (before the mixing) as the power in the signal component divided by the power in the noise component for the signal at that point. Compute SNR_{out} in terms of SNR_{in}.

Problem 3 extra workspace.

Problem 4. The message signal $m(t) = 5\text{sinc}(200\text{t})$ frequency modulates the carrier $c(t) = 50\cos(2\pi f_c t)$. The modulation index is 8.

   a. Write an expression for the modulated signal $x(t)$.

   b. What is the maximum frequency deviation of the modulated signal?

   c. What is the power content of the modulated signal?

   d. Find the bandwidth of the modulated signal?

Problem 4 extra workspace.

Problem 5. The phase modulated signal has the form

$$m(t) = 10 \cos \left[2\pi f_c t + 2 \sin(2\pi f_m t) \right]$$

where $f_c = 1$ MHz and $f_m = 1$ kHz.

    a. Determine the modulation index.

    b. Using Carson's rule determine the transmitted signal bandwidth.

Problem 6. The wide-sense stationary process $X(t)$ has a correlation function denoted by $R_X(\tau)$ and a power spectral density denoted by $S_X(f)$. Suppose we form a new random process as

$$Y(t) = X(t) - X(t - T)$$

where T is some fixed constant.

a. Find the correlation function for $Y(t)$. Is $Y(t)$ wide-sense stationary?

b. Find the power spectral density of $Y(t)$. (Note: depending on how you work part (b) it can be worked independent of part (a).)

Problem 6 extra workspace.

Problem 7. Consider a random process $X(t)$ defined by

$$X(t) = U \cos 2\pi f t + V \sin 2\pi f t$$

where f is a constant and U and V are random variables.

a. Show the condition
$$E[U] = E[V] = 0$$
is necessary for the random process to be stationary.

b. Show that $X(t)$ is wide sense stationary if and only if U and V are uncorrelated with equal variance σ^2.

Problem 7 extra workspace.

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

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