Exam 1
February 1, 2006

ECE 222: Signals and Systems
Dr. McNames

• Write your full name above.
• Keep your exam flat during the entire exam.
• If you have to leave the exam temporarily, close the exam and leave it face down while you are out of the room.
• Turn off any cell phones or pagers that might interrupt the exam.
• Do not open the exam until instructed to do so.
• Do not use separate scratch paper. If you need more space, use the backs of the exam pages and write a note directing my attention to these pages.
• You will have 100 minutes to complete the exam.
• If you have extra time, double check your answers.
• Remember to include units with each of your answers.

Problem 1:______ / 14
Problem 2:______ / 10
Problem 3:______ / 15
Problem 4:______ / 11

Total:______ / 50
1. Signals and Systems Concepts (14 pts)
Circle the appropriate answers to the multiple choice questions below. Note that some questions may have more than one correct answer that must be circled. One point will be deducted for every incorrect answer, but the minimum score for any question is 0 pts.

a. (3 pts) Which of the following signals are power signals (finite, non-zero power)?
   \[ x(t) = u(t+3) - u(-t) \]
   \[ x(t) = u(t) - u(t-3) \]
   \[ x(t) = e^{-t} u(-t) \]
   \[ x[n] = \exp(7n-j\pi n) u[n] \]
   \[ x(t) = \cos(12t + \pi/3) \]
   \[ x(t) = e^t u(t) \]

b. (3 pts) Which of the following signals are energy signals (finite, non-zero energy)?
   \[ x(t) = u(t+3) - u(-t) \]
   \[ x(t) = u(t) - u(t-3) \]
   \[ x(t) = e^{-t} u(-t) \]
   \[ x[n] = \exp(7n-j\pi n) u[n] \]
   \[ x[n] = \cos(12t + \pi/3) \]
   \[ x(t) = e^t u(t) \]

c. (1 pt) What is the imaginary part of the signal \( x(t) = 2 \exp(j5t) \)?
   \[ \text{Im\{x(t)\}} = \boxed{} \]

d. (1 pt) What is the magnitude of the signal \( x(t) = -3 \exp(j5t) \)?
   \[ |x(t)| = \boxed{} \]

e. (1 pt) What is the fundamental period of the signal \( x(t) = e^{12t} \)?
   \[ T_0 = \boxed{} \]

f. (1 pt) What is the value of the following expression?
   \[ \int_{-\infty}^{\infty} \cos(0.25\pi t) \delta(t-8) \ dt = \boxed{} \]

g. (1 pt) Evaluate the following sum.
   \[ \sum_{n=-\infty}^{\infty} \delta[n+3] = \boxed{} \]

h. (1 pt) Evaluate the following integral.
   \[ \int_{-\infty}^{\infty} \delta(t+27) \ dt = \boxed{} \]

i. (1 pt) Write an expression for \( x[n] = 2\exp(0.3n+j0.2n) \) in rectangular form.
   \[ x[n] = \boxed{} \]

j. (1 pt) Write an expression for \( x(t) = 2\exp(j3t) \) in rectangular form.
   \[ x(t) = \boxed{} \]
2. Fundamentals of Signals (10 pts)
Use the following signal to answer the questions below. You may assume that the signal is equal to zero outside of the time range shown.

a. (1 pt) What is the signal energy of $x[n]$?

$$ E_x = $$

b. (2 pts) Draw $-x[4-n]$ below.


c. (2 pts) Draw the even component of $x[n]$ below.
2. Fundamentals of Signals Continued (10 pts)
Use the following signal to answer the questions below. You may assume that the signal is equal to zero outside of the time range shown.

![Signal Graph]

d. (1 pt) What is the average value of \( x(t) \)?

e. (2 pts) Draw the \( x(0.5t + 1) \) below.

f. (2 pts) Draw the even component \( x(t) \) below.
3. Properties of Systems (15 pts)
In each cell of the table enter a Y if the system has the corresponding property, N if the system
does not have the property, and leave the cell blank if you don’t know. The continuous-time
system has an input signal \( x(t) \) and each discrete-time system has an input signal \( x[n] \). You can
assume the circuit elements in the diagrams are ideal and that the capacitor in Circuit 1 is
uncharged at \( t= -\infty \).

Grading: Every correct answer is worth 0.5 pts and every incorrect answer is worth -0.5 pts. The
total score will be rounded up. If your total score is negative, you will receive 0 pts. If your total
score exceeds 15, you will receive 15 pts. Thus, for example, 29 correct answers and 16
unanswered entries would receive full credit.

<table>
<thead>
<tr>
<th>System</th>
<th>Memoryless</th>
<th>Invertible</th>
<th>Causal</th>
<th>Stable</th>
<th>Time Invariant</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y(t) = \int_{-25}^{\infty} x(\tau) d\tau )</td>
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<td>( y[n] = x[3n-4] )</td>
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<td>( y(t) = -7 \frac{dx(t)}{dt} )</td>
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<td>( y[n] = \cos(0.3\pi n) x[n] )</td>
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<td>( y(t) = x(t) )</td>
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<tr>
<td>Circuit 3</td>
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<td>Circuit 2</td>
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<tr>
<td>Circuit 1</td>
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</table>
4. Convolution Sum (11 pts)
Consider a linear time-invariant discrete-time system with the input signal $x[n]$ and impulse response $h[n]$ shown below for the questions that follow. You may assume that both signals are equal to zero outside of the time range shown.

![Graph showing input signal x[n] and impulse response h[n]]

a. (3 pts) Which properties does this system have? (Circle all that apply)
   - Memoryless
   - Causal
   - Time Invariant
   - Stable
   - Linear

b. (1 pt) What is the most recent sample of the input signal $x[n]$ that affects the system output at time $n$? For example, if $h[n] = \delta[n-3]$, then the most recent sample of the input that affects the system output would be $n-3$ because $y[n] = x[n-3]$.

c. (1 pt) If the input signal is bounded such that $|x[n]| \leq 7$, what is the maximum possible output that the system could produce? If the maximum is unbounded, write $\infty$.
   $\max y[n] = \quad$

d. (1 pt) Draw the discrete-time signal $h[n - k]$ versus $k$ for $n=0$ on the axis given below.

![Graph showing discrete-time signal h[n - k] versus k]

e. (1 pt) What is the output of the system for $n=0$?
   $y[0] = \quad$
4. Convolution Sum Continued (11 pts)
The input signal \( x[n] \) and impulse response \( h[n] \) are repeated below from the previous page.

\[ x[n] = \begin{cases} 2 & \text{for } n = -1 \\ 1 & \text{for } n = 0 \\ -2 & \text{for } n = 2 \\ 3 & \text{for } n = 3 \\ -2 & \text{for } n = 4 \\ 1 & \text{for } n = 5 \\ -1 & \text{for } n = 6 \\ 5 & \text{for } n = 7 \\ 6 & \text{for } n = 8 \end{cases} \]

\[ h[n] = \begin{cases} 1 & \text{for } n = 0 \\ 2 & \text{for } n = 1 \\ -1 & \text{for } n = 2 \\ 3 & \text{for } n = 3 \end{cases} \]

f. (1 pt) Draw the discrete-time signal \( h[n - k] \) versus \( k \) for \( n=2 \) on the axis given below.

\[ y[2] = \]

h. (1 pt) Draw the discrete-time signal \( h[n - k] \) versus \( k \) for \( n=5 \) on the axis given below.

\[ y[5] = \]