NAME: 25 February 2015
EE301 Signals and Systems Exam 1

Cover Sheet

Test Duration: 75 minutes.
Coverage: Chaps. 1,2
Open Book but Closed Notes.
One 8.5 in. x 11 in. crib sheet
Calculators NOT allowed.
DO NOT UNSTAPLE THE EXAM!
All work should be done in the space provided.
You must show ALL work or explain answer for each problem to receive full credit.

Prob. No.	**Topic(s)**	**Points**
1.	Continuous Time Signals and System Properties	50
2.	Discrete Time Signals and System Properties	50

VIP If you want to refer to the input signal and output signal for one part of a problem when solving a later part, use that part's letter as a subscript, e.g., you can refer to the input signal and corresponding output signal for part (d) of Prob. 1 as $x_d(t)$ and $y_d(t)$, respectively.

VIP: Solving and part, you can just write: z(t)= Formula A with a=-3 and b =-2 BUT don't have to write out Formula A substituting a=-3 and b=-2. Just use z(t) for remainder of your solution.

Formula A: $$e^{at}u(t) * e^{bt}u(t) = \frac{1}{a-b}e^{at}u(t) + \frac{1}{b-a}e^{bt}u(t) \quad (1)$$

Formula B: $$\alpha^n u[n] * \beta^n u[n] = \frac{\alpha}{\alpha-\beta}\alpha^n u[n] + \frac{\beta}{\beta-\alpha}\beta^n u[n] \quad (2)$$

Formula C: if $x(t) * h(t) = y(t)$ then: $a\,x(t-t_1) * b\,h(t-t_2) = ab\,y(t-(t_1+t_2))$ (3)

Formula D: if $x[n] * h[n] = y[n]$ then: $a\,x[n-n_1] * b\,h[n-n_2] = ab\,y[n-(n_1+n_2)]$ (4)

Formula E: if $x(t) * h(t) = y(t)$ then: $x(t-t_0) * h(t) = y(t-t_0)$ and $x(t) * h(t-t_0) = y(t-t_0)$ (5)

Formula F: if $x[n] * h[n] = y[n]$ then: $x[n-n_0] * h[n] = y[n-n_0]$ and $x[n] * h[n-n_0] = y[n-n_0]$ (6)

Prob. 1. Consider the LTI system defined as **System 1:** $y(t) = \int_{t-4}^{t} x(\tau)d\tau$

(a) Determine and plot the impulse response of the system, $h_1(t)$.

(b) Is the system causal? Justify your answer using the impulse response.

(c) Is the system stable? Justify your answer using the impulse response.

(d) Determine and write a closed-form expression for the output ($y(t)$) of System 1 for the input

$$x(t) = 4\, e^{-2t}u(t)$$

(e) Determine a closed-form expression for the output ($y(t)$) of System 1 for the input

$$x(t) = 4e^{-2t}u(t-4)$$

(f) Determine and write a closed-form expression for the output $y(t)$ of System 1 for the input

$$x(t) = 4e^{-2t}\{u(t) - u(t-4)\}$$

(g) Determine and plot the output ($y(t)$) of System 1 for the input

$$x(t) = 3\{u(t-2) - u(t-6)\}$$

(h) Consider a second LTI system described by the following difference equation. Determine the impulse response for System 2, denoted $h_2(t)$.

$$\textbf{System 2:} \quad y(t) = \int_{-\infty}^{t} e^{-\frac{1}{2}(t-\tau)}x(\tau)d\tau$$

(i) Determine a closed-form expression for the output $y[n]$ when the input is

$$x(t) = 6e^{-3t}u(t-2)$$

(j) Determine and write a closed-form expression for the output of System 2, $y(t)$, for the input

$$x(t) = \{u(t) - u(t-4)\}$$

(k) Determine and write a closed-form expression for the output of System 2, $y(t)$, for the input

$$x(t) = 2\{u(t) - u(t-4)\} - 3\{u(t-6) - u(t-10)\}$$

(l) Systems 1, 2, and 3 are in series where System 3 is defined below. Determine the overall impulse response, denoted $h_0(t)$, where: **System 3:** $y(t) = \frac{d}{dt}x(t)$

Problem 2.

(a) Consider the causal LTI System characterized by the difference equation below. Write an expression for the impulse response of this system, denoted $h_1[n]$. **System 1:** $y[n] = -\frac{3}{4}y[n-1] + x[n]$

(b) Is the system causal? Justify your answer using the impulse response.

(c) Is the system stable? Justify your answer using the impulse response.

(d) Does the system have memory or is it memoryless? Justify your answer using the impulse response.

(e) Determine and write a closed-form expression for the output $y[n]$ of System 1 for the input

$$x[n] = 4\left(\frac{1}{2}\right)^n u[n]$$

(f) Determine a closed-form expression for the output $y[n]$ of System 1 when the input is

$$x[n] = 4\left(\frac{1}{2}\right)^n u[n-4]$$

(g) Determine and write a closed-form expression for the output $y[n]$ of System 1 for the input

$$x[n] = 4\left(\frac{1}{2}\right)^n \{u[n] - u[n-4]\}$$

(h) Determine a closed-form expression for the output $y[n]$ of System 1 when the input is

$$x[n] = 4\{u[n] - u[n-4]\}$$

(i) Consider a second LTI system described by the following difference equation. Determine the impulse response for System 2, denoted $h_2[n]$. You can write your answer in sequence form, using an arrow to denote the $n = 0$ value.

$$\text{System 2:} \quad y[n] = y[n-1] + x[n] - x[n-4]$$

(j) Determine and write a closed-form expression for the output of System 2 ,$y[n]$, for the input below. Write answer in sequence form, using an arrow to denote the $n = 0$ value.

$$x[n] = \{u[n] - u[n-4]\}$$

(k) Determine and write a closed-form expression for the output of System 2 ,$y[n]$, for the input below. Write answer in sequence form, using an arrow to denote the $n = 0$ value.

$$x[n] = 2\{u[n] - u[n-4]\} - 3\{u[n-6] - u[n-10]\}$$

(l) Determine a closed-form expression for the output $y[n]$ of System 2 when the input is

$$x[n] = 2\delta[n] - \delta[n-1]$$

(m) Determine $y[n]$ as the convolution of the two sequences below. Write your answer in sequence form indicating with an arrow which value corresponds to $n = 0$. You can use next page as well as the space below to show all your work.

$$x[n] = 8\left(\frac{1}{2}\right)^n \{u[n] - u[n-4]\} \qquad h[n] = 16\left(-\frac{1}{2}\right)^n \{u[n] - u[n-4]\}$$