NAME: **26 September 2013**

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.
This test contains **two** problems.
All work should be done on the sheets provided.
You must show work or explain answer for each problem to receive full credit.
Plot your answers on the graphs provided.
WRITE YOUR NAME ON EVERY SHEET.

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

$$\begin{aligned} y_1(t) = \{u(t)-u(t-T_1)\} * t\{u(t)-u(t-T_2)\} &= \frac{t^2}{2}\{u(t)-u(t-T_1)\} \\ &+ \left(T_1 t - \frac{T_1^2}{2}\right)\{u(t-T_1)-u(t-T_2)\} \\ &+ \left(-\frac{t^2}{2} + T_1 t + \frac{T_2^2 - T_1^2}{2}\right)\{u(t-T_2)-u(t-(T_1+T_2))\} \end{aligned} \tag{1}$$

$$\begin{aligned} \{u(t)-u(t-T_1)\} * [-(t-T_2)\{u(t)-u(t-T_2)\}] &= \left(-\frac{t^2}{2} + T_2 t\right)\{u(t)-u(t-T_1)\} \\ &+ \left(-T_1 t + \frac{2T_1T_2 + T_1^2}{2}\right)\{u(t-T_1)-u(t-T_2)\} \\ &+ \left(\frac{t^2}{2} - (T_1+T_2)t + \frac{(T_1+T_2)^2}{2}\right)\{u(t-T_2)-u(t-(T_1+T_2))\} \end{aligned} \tag{2}$$

$$y_2(t) = \{u(t)-u(t-T_1)\} * [-(t-T_2)\{u(t)-u(t-T_2)\}] = y_1(-(t-(T_1+T_2)) \tag{3}$$

Prob. 1. [50 pts] Consider the LTI system characterized by the I/O relationship:

$$y(t) = \int_{t-2}^{t} x(\tau) d\tau \tag{4}$$

(a) Determine and plot the impulse response of this system, denoted $h(t)$, in the spaced provided on the sheets attached.

(b) Determine and plot the output $y_1(t)$ in the space provided when the input to the system is the rectangular pulse below:

$$x_1(t) = \{u(t) - u(t-1)\}$$

(c) Determine and plot the output $y_2(t)$ in the space provided when the input to the overall system is the ramp-down triangular pulse.

$$x_2(t) = -(t-2)\{u(t) - u(t-2)\}$$

(d) Determine and plot the output $y_3(t)$ in the space provided when the input to the system is the ramp-up triangular pulse:

$$x_3(t) = t\{u(t) - u(t-2)\}$$

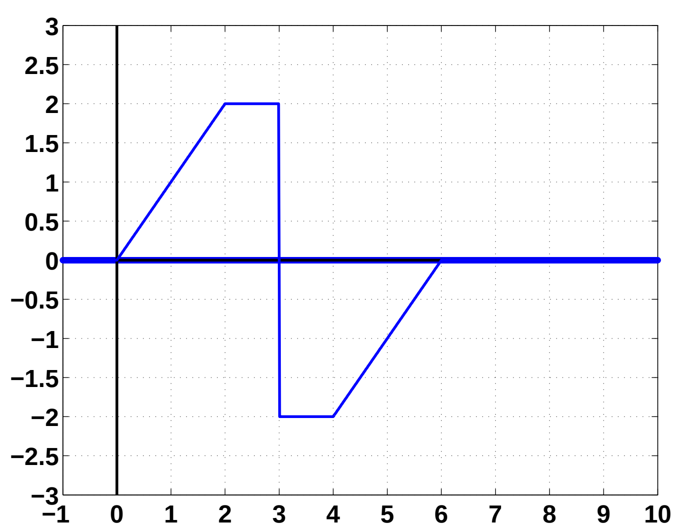
(e) *GOAL:* determine the output $y(t)$ when the input to the system is $x(t)$ plotted below.

(i) Express $x(t)$ in terms of possibly amplitude-scaled and time-shifted versions of $x_i(t)$, $i = 1, 2, 3$, defined in parts (b), (c), and (d). **You can use any of the $x_i(t)$ functions more than once in your expression, and your expression can sum more than just three terms.** For example, (this is NOT correct): $x(t) = \sqrt{2}\, x_1(t-\pi) - \sqrt{\pi}\, x_2(t-\sqrt{2}) + 3\, x_3(t-7) - x_3(t-9) + x_2(t-2\pi) - x_1(t-\sqrt{11})$

(ii) Similarly express $y(t)$ in terms of $y_i(t)$, $i = 1, 2, 3$, answers to parts (b), (c), (d).

(iii) Plot $y(t)$ in the space provided on the sheets attached.

Input $x(t)$



Problem 2. [50 points] For parts (a) and (b), show your work and do your plots in the space provided on the sheets attached. Put the answers for the remaining parts on this page.

(a) For parts (a) and (b), consider causal LTI System 1 characterized by the following difference equation below. Determine and plot (stem plot) the impulse response $h_1[n]$.

$$\text{System 1:} \quad y[n] = x[n] + x[n-1] + x[n-2] - x[n-3]$$

(b) Compute the convolution $y[n] = x[n] * h[n]$ with $x[n]$ below, do a stem plot of $y[n]$.

$$x[n] = \{-\delta[n] + \delta[n-1] + \delta[n-2] + \delta[n-3]\}$$

(c) For the REST of this problem, consider System 2 characterized by the equation below:

$$\text{System 2:} \qquad y[n] = x[n] + (-1)^n x[n-1] + x[2(n-2)]$$

[(b)-(i)] Is System 2 linear? State Yes or No, and explain your answer.

Answer(i):

[(b)-(ii)] Is System 2 Time Invariant? State Yes or No, and explain your answer.

Answer(ii)

[(b)-(iii)] Let $h[n]$ denote the output of System 2 when the input is $\delta[n]$. For any other input, $x[n]$, is the output $y[n]$ equal to the convolution of $x[n]$ with the impulse response $h[n]$? State Yes or No, and briefly explain your answer.

Answer(iii)

[(b)-(iv)] GIVEN: with input to System 2 equal to sinewave $x[n] = e^{jw_o n}$, the output is a sum of sinewaves. Determine the frequencies present in the output in terms of ω_o.

Answer(iv)

[(b)-(v)] Is System 2 stable? State Yes or No, and briefly explain your answer.

Answer(v)

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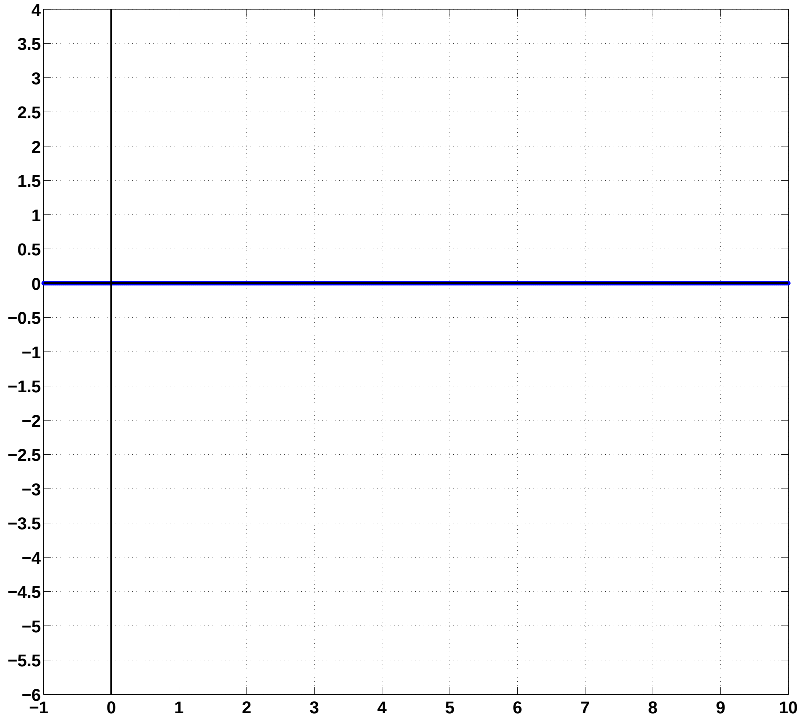
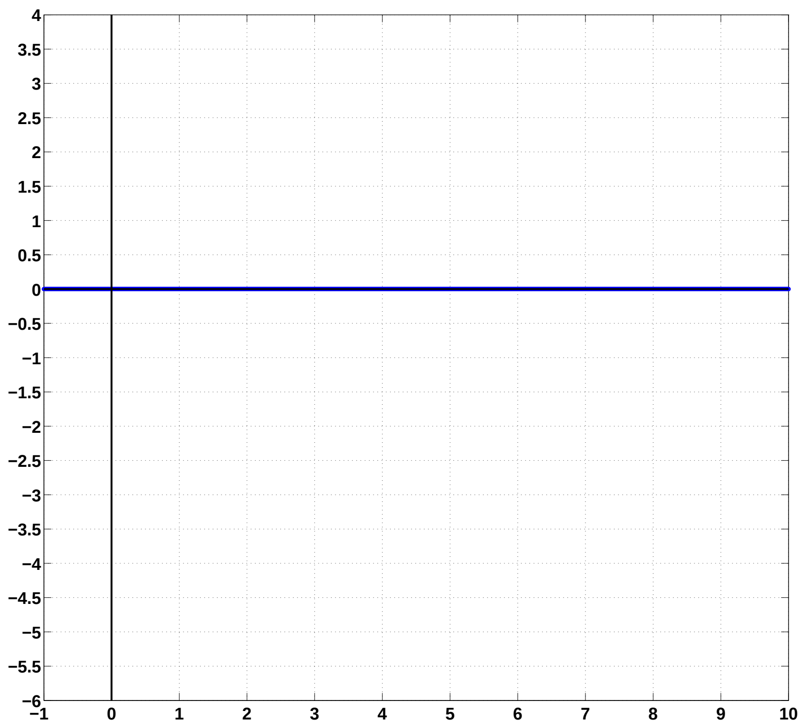


Plot your answer for $h(t)$ for Problem 1 (a) here.



Plot your answer for $y_1(t)$ for Problem 1 (b) here.

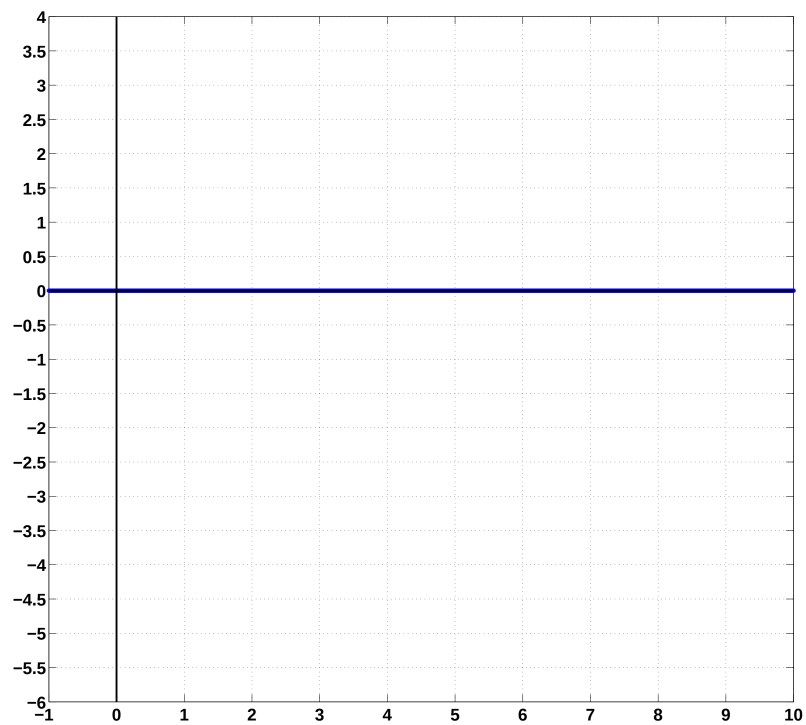
1(c): For each value of t, write the value of $y_2(t)$ in the table below.

t	$y_2(t)$
$t = 0$	
$t = 1$	
$t = 2$	
$t = 3$	
$t = 4$	

Mark the correct box with an X for each range for $y_2(t)$.

Range for t	Linear pos. slope	Linear neg. slope	Quadratic Concave Up	Quadratic Concave Down
$0 < t < 1$				
$1 < t < 2$				
$2 < t < 3$				
$3 < t < 4$				

Plot $y_2(t)$ below.



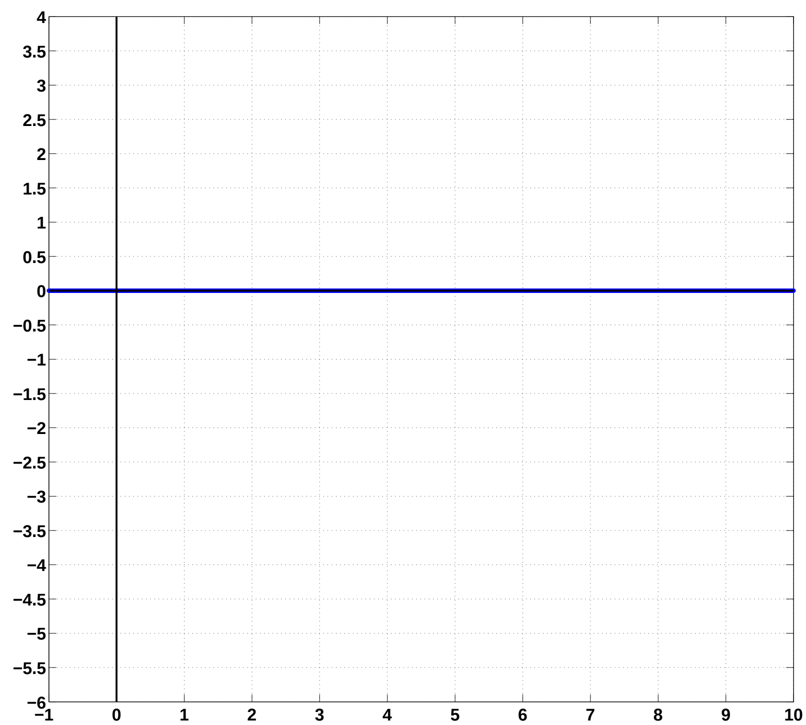
1(d): For each value of t, write the value of $y_3(t)$ in the table below.

t	$y_3(t)$
$t = 0$	
$t = 1$	
$t = 2$	
$t = 3$	
$t = 4$	

Mark the correct box with an X for each range for $y_3(t)$.

Range for t	Linear pos. slope	Linear neg. slope	Quadratic Concave Up	Quadratic Concave Down
$0 < t < 1$				
$1 < t < 2$				
$2 < t < 3$				
$3 < t < 4$				

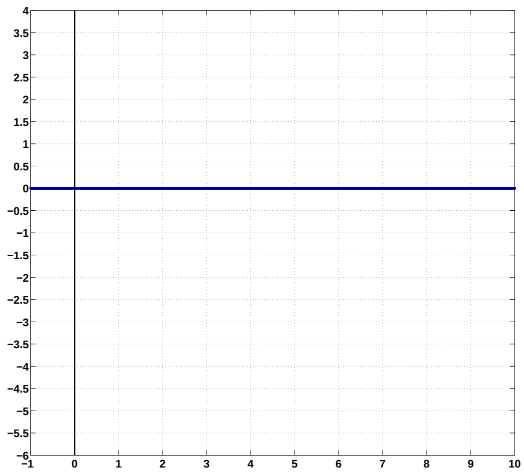
Plot $y_3(t)$ below.

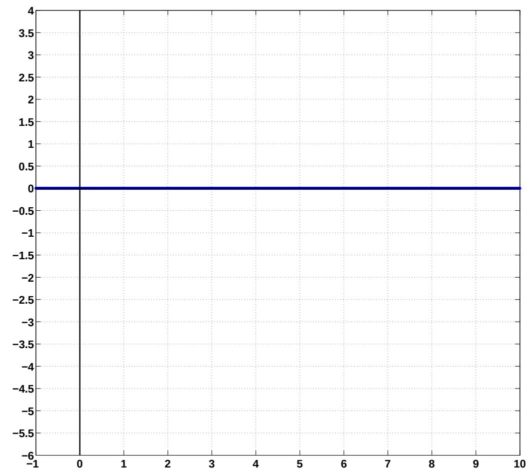


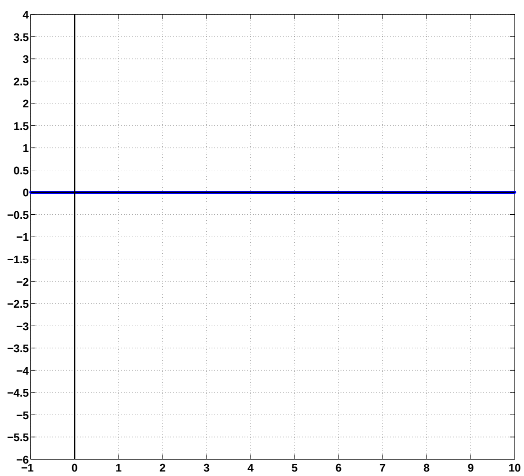
1 (e). Express $x(t)$ in terms of $x_i(t)$, $i = 1, 2, 3$.

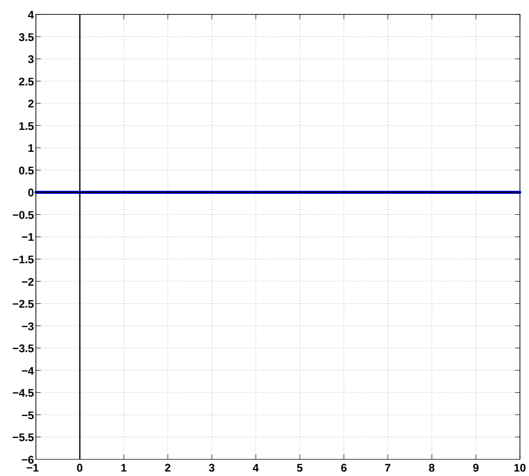
1 (e). Express $y(t)$ in terms of $y_i(t)$, $i = 1, 2, 3$.

You can use the plots below if they're helpful for answering 1(e).









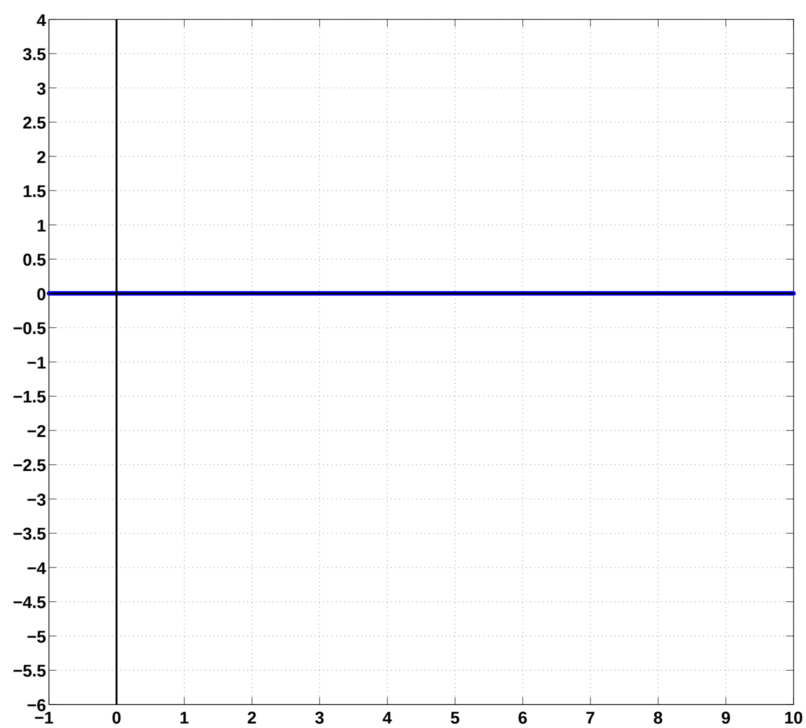
Part (e). For each range of t, put an X in the correct box in the table below.

Range for t	Linear pos. slope	Linear neg. slope	Quadratic Concave Up	Quadratic Concave Down
$0 < t < 1$				
$1 < t < 2$				
$2 < t < 3$				
$3 < t < 4$				
$4 < t < 5$				
$5 < t < 6$				
$6 < t < 7$				
$7 < t < 8$				

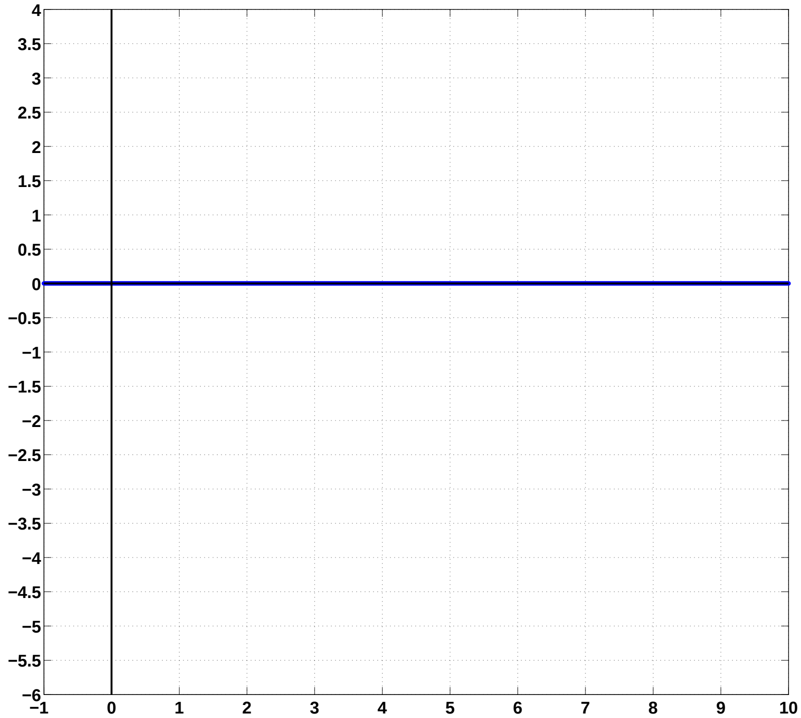
For each value of t, write the value of $y(t)$ in the table below.

t	$y(t)$
$t = 0$	
$t = 1$	
$t = 2$	
$t = 3$	
$t = 4$	
$t = 5$	
$t = 6$	
$t = 7$	
$t = 8$	

Plot $y(t)$ for Prob1, Part (e) below.



Plot your answer $h[n]$ to Problem 2, part (a) on this page.



Show your work and plot your answer $y[n]$ to Prob 2 (b) on this page.