ECE 300
Signals and Systems

Exam 1
27 September, 2007

NAME ____

This exam is closed-book in nature. You are not to use a calculator or computer during the exam.

Problems 1-4________ / 16
Problem 5 ________ / 29
Problem 6 ________ / 25
Problem 7 ________ / 25

Exam 1 Total Score: _______ / 100

Name ____ CM____________

Problems 1-4 are worth 4 points each.

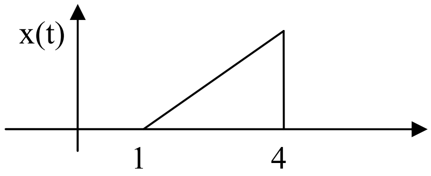
1. Which of the following statements is the best simplification of: $\int_{-2}^{t} x(\lambda - t_0)\delta(\lambda)d\lambda$

a) 0 b) $x(t-t_0)\delta(t)$ c) $x(-t_0)u(t)$ d) $x(-t_0)\delta(t)$ e) none of these

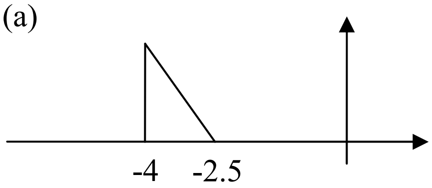
2 . The average power in the signal $x(t) = u(t) - u(-t)$ is

a) 0 b) $\frac{1}{2}$ c) 1 d) ∞ e) none of these

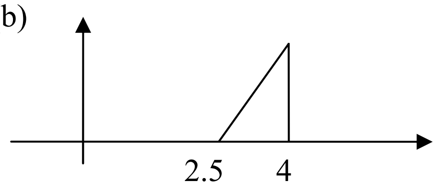
3. Given x(t) below, which of the plots labeled (a) – (d) represents $x(2(\ t\quad 2))$.



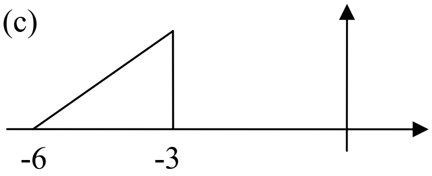
(a)



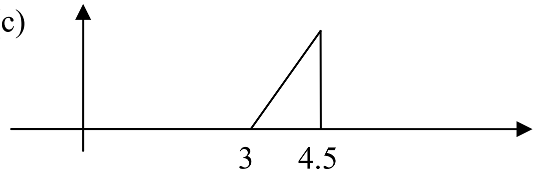
(b)



(c)



(c)



4. The signal $x(t) = \cos(4\pi t + \pi / 2) + \sin(6\pi t)$ is

a) not periodic

b) periodic with fundamental period 6π seconds

c) periodic with fundamental period 1 second

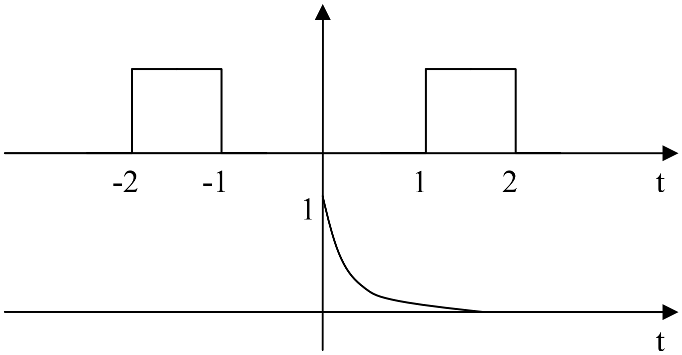
d) periodic with fundamental period 3/2 seconds

e) none of the above

Name ____ CM___________

5. Graphical Convolution (29 points)

Use graphical convolution to determine the intervals of integration and their corresponding integrals $y(t) = x(t) * h(t)$ as shown in the plots below. Use x(t) as the signal to “flip and shift” (i.e. x(t-λ)) for the convolution. **DO NOT solve the integrals, just set them up.**



$h(t) = u(t+2) - u(t+1) +$

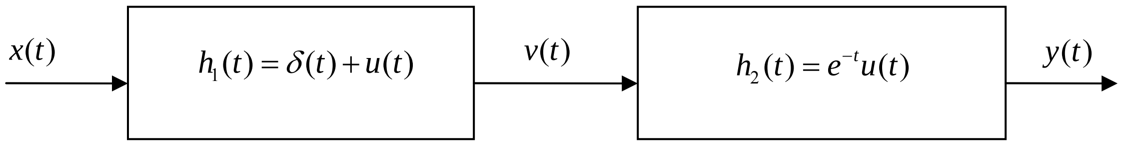
$x(t) = e^{-2t}u(t)$

6. Impulse Response (25 points)
For each of the following systems, determine the impulse response $h(t)$ between the input $x(t)$ and output $y(t)$. *Be sure to include any necessary unit step functions.*

a) $y(t) = x(t) + 2x(t-2)$

b) $\dot{y}(t) - y(t) = 2x(t)$

c) For the following system, with the impulse responses of each subsystem shown,



Determine the impulse response of the **system** (relating $y(t)$ and $x(t)$).

Name ____ CM___________

7. System Properties (25 points)

a) Fill in the following table with a Y (Yes) or N (No). Only your responses in the table will be graded, not any work. Assume $x(t)$ is the system input and $y(t)$ is the system output. Also assume we are looking at all times (positive and negative times).

System	Linear ?	Time-Invariant?	Memoryless?	Causal?
$\dot{y}(t)+t^2y(t)=x(t+1)$				
$y(t)=x\left(1-\frac{t}{2}\right)$				
$y(t)=2$				
$y(t)=x(2t)$				

b) For the system described below, determine the value of "c" that will make the system time-invariant. Use a formal technique such as we used in class (and on the homework) and justify your answer.

$$y(t)=e^{t}\int_{c}^{t}e^{-\lambda}x(\lambda)d\lambda$$

Name ____ CM___________

Name ____ CM____________

Some Potentially Useful Relationships

$$E_\infty = \lim_{T\to\infty} \int_{-T}^{T} \left|x(t)\right|^2 dt = \int_{-\infty}^{\infty} \left|x(t)\right|^2 dt$$

$$P_\infty = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} \left|x(t)\right|^2 dt$$

$$e^{jx} = \cos(x) + j\sin(x) \qquad j = \sqrt{-1}$$

$$\cos(x) = \frac{1}{2}\left[e^{jx} + e^{-jx}\right] \qquad \sin(x) = \frac{1}{2j}\left[e^{jx} - e^{-jx}\right]$$

$$\cos^2(x) = \frac{1}{2} + \frac{1}{2}\cos(2x) \qquad \sin^2(x) = \frac{1}{2} - \frac{1}{2}\cos(2x)$$

$$\mathrm{rect}\left(\frac{t-t_0}{T}\right) = u\left(t - t_0 + \frac{T}{2}\right) - u\left(t - t_0 - \frac{T}{2}\right)$$