King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE207: Signals & Systems (121)

Final Exam

Serial Number

Ver. 2

Jan. 3rd, 2013
7:00-9:30PM

Name:___________________________

ID#________________________________

Question	Mark
1	/30
2	/10
3	/15
4	/15
5	/15
6	/15
Total	/100

Instructions:

1. This is a closed-books/notes exam.
2. The duration of this exam is one and half hours.
3. Read the questions carefully. Plan which question to start with.
4. LABEL ALL SIGNIFICANT VALUES ON BOTH AXES OF ANY SKETCH
5. Work on your own.
6. Strictly no mobile phones are allowed. Do not even look at them !

Good luck

Mark	sec	Timing	Instructor
	1	UT8:30	Dr. M. Landolsi
	3	UT 10:00	Dr. Ali Al-Shaikhi
	4	SMW10:00	Dr. Azzedine Zerguine
	5	SMW 11:00	Dr. Ali Muqaibel

<u>Problem 1:</u> [32pts] **Choose the best answer. Fill in the table with CLEAR answers**

Question	1	2	3	4	5	6	7	8
Answer								

Question	9	10	11	12	13	14	15
Answer							

1) Which of the following signal has <u>finite</u> energy? Note: $r(t) = tu(t)$
   a. $u(t)$-$u(t$-5)
   b. $r(t)$
   c. $r(t)$-$r(t$-2)
   d. sin (3t)
   e. $u(t)$

2) Which of the following systems (defined by their input/output relations) is causal?
   a. $y(t)= x(-2t)$
   b. $y(t) = x(t+5) - 5$
   c. $y(t) = x(t^{1/2})$
   d. $y(t) = x(t) + t$
   e. $y(t) = x(t^2)$

3) The integral $\int_{-1}^{5} e^{-4t^2}\cos(t^2)\delta(t-10)dt$ is equal to:
   a. $e^{-400}\cos(100)\delta(t-10)$
   b. $e^{-400}\cos(100)$
   c. $\delta(t-10)$
   d. $e^{-400}\sin(100)$
   e. 0

4) The step response of a system with impulse response $h(t)= u(t)-u(t-5)$ is:
   a. $\delta(t)-\delta(t-5)$
   b. 5 $r(t)$
   c. $r(t)-r(t-5)$
   d. $u(t)$
   e. 0

5) The system defined by $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$ is
   a. linear and time-invariant.
   b. linear and non-causal.
   c. non-linear and time-invariant.
   d. non-linear and time varying.
   e. memory-less (static).

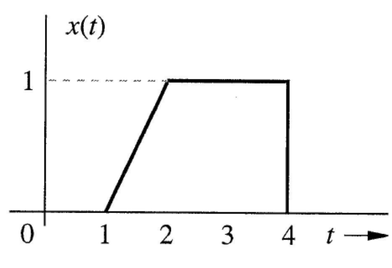
6) The signal $x(t) = e^{j2t}$ is
   a. a power signal with power equal to 0
   b. a power signal with power equal to 1
   c. neither power nor energy signal
   d. an energy signal with energy equal to 1
   e. an energy signal with energy equal to 0

7) Determine the Fourier transform of $x(t) = e^{-|t|}$
   a. $X(\omega) = \frac{1}{1 + j\omega}$
   b. $X(\omega) = \frac{1}{1 - j\omega}$
   c. $X(\omega) = \frac{2}{1 + \omega^2}$
   d. $X(\omega) = \frac{1}{1 + \omega}$
   e. $X(\omega) = \frac{1}{1 - \omega}$

8) The inverse Fourier Transform of $X(\omega) = \frac{1}{2} rect\left(\frac{\omega - 10}{2}\right) + \frac{1}{2} rect\left(\frac{\omega + 10}{2}\right)$ is
   a. $x(t) = \text{sinc}(t)\cos(10t)$
   b. $x(t) = \text{sinc}(t)\cos(5t)$
   c. $x(t) = \text{sinc}(2t)\cos(10t)$
   d. $x(t) = \frac{\sin t}{\pi t}\cos(5t)$
   e. $x(t) = \frac{\sin t}{\pi t}\cos(10t)$

9) The inverse Laplace transform of $\frac{24}{s(s+8)}$ is
   a. $3[1 - e^{-8t}]u(t)$
   b. $6[4 - 3e^{-8t}]u(t)$
   c. $24u(t) + 6e^{-8t}u(t)$
   d. $\delta(t) + 3u(t)$
   e. $24 + e^{-8t}u(t)$

10) Find the Laplace transform of $x(t)$ shown in the figure.



   a. $X(s) = \frac{1}{s^2}e^{-s} + \frac{1}{s^2}e^{-2s} + \frac{1}{s}e^{-4s}$
   b. $X(s) = \frac{1}{s^2}e^{-s} - \frac{1}{s^2}e^{-2s}$
   c. $X(s) = \frac{1}{s^2}e^{-s} + \frac{1}{s^2}e^{-4s} - \frac{1}{s}e^{-2s}$
   d. $X(s) = \frac{1}{s^2}e^{-s} - \frac{1}{s^2}e^{-2s} - \frac{1}{s}e^{-4s}$
   e. $X(s) = \frac{1}{s^2}e^{-s} - \frac{1}{s^2}e^{-4s}$

11) What is the minimum sampling frequency so the signal can be reconstructed correctly for $x(t) = \sin 2\pi t + \cos 8\pi t$,

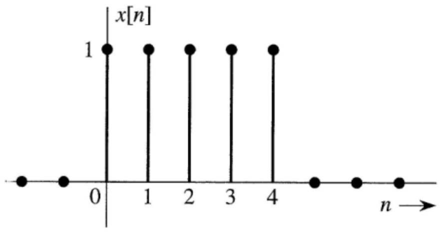
a. 10 Hz
b. 2 Hz
c. 4 Hz
d. 6 Hz
e. 8 Hz

12) For a sampled signal, aliasing (spectrum overlapping) is a phenomenon that results when:

a. we over-sample (sample at very high rate).
b. we transfer the signal to the z-domain.
c. we sample below Nyquist rate.
d. we use the sifting (sampling) property of delta functions.
e. the signal is sampled at 3 times the highest frequency.

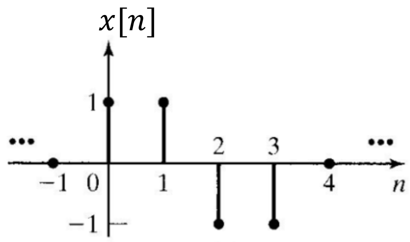
13) Find the z-transform of $x[n]$ shown in the figure

a. $X(z) = 1 + \frac{1}{z} + \frac{1}{z^2}$
b. $X(z) = \frac{z^4+z^3+z^2+2z}{z^4}$
c. $X(z) = z^{-2} + z^{-3} + z^4$
d. $X(z) = \frac{z}{z-1}(1 - z^{-5})$
e. $X(z) = 1 + z^{-1} + 2z^{-2} + 3z^{-3} + 4z^{-4}$



14) Convolving $x[n]$ with itself, the output is y[n]. The value of y[3] is equal to:

a. -4
b. -2
c. 0
d. 2
e. 4



15) The inverse z-transform of $\frac{1}{(z-1)(z+0.5)}$ is:

a. $-2\delta[n] + \left[\frac{2}{3} + \frac{4}{3}(-0.5)^n\right] u[n]$

b. $\left[\frac{2}{3} + \frac{4}{3}(-0.5)^n\right] u[n]$

c. $\left[\frac{4}{3} + \frac{2}{3}(-0.5)^n\right] u[n]$

d. $\left[\frac{2}{3} + \frac{4}{3}(0.5)^n\right] u[n]$

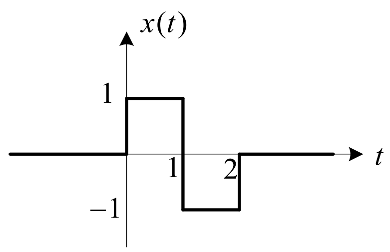
e. $-2\delta[n]$

Problem 2:

The impulse response of an LTI system is given by, $h(t) = \frac{1}{2}e^{-\frac{t}{2}}u(t)$

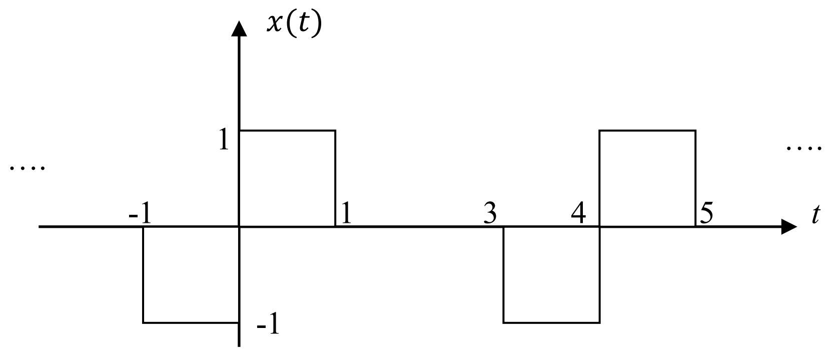
a) Find the step response $s(t)$ [i.e., the response to a unit step input $u(t)$].

b) Express $x(t)$,shown in the figure, in terms of step functions.



c) Find the LTI system's response for this input signal $x(t)$.

Problem 3:
Consider the periodic signal $x(t)$ shown below:



a. Specify the fundamental frequency ω_0 of $x(t)$, and indicate if $x(t)$ is even, odd or neither.

$\omega_0 =$ $x(t)$ is

b. Find the Exponential Fourier Series coefficients C_k of $x(t)$, and verify that they are purely imaginary.

c. Plot the 2-sided amplitude and phase spectra of x(t) (up to the 5^{th} harmonic).

Problem 4:

A circuit is described by the following differential equation:

$$\frac{dy(t)}{dt}+2y(t)=2x(t)$$

a) Show that the transfer function of the circuit is given by: $H(\omega)=\dfrac{2}{2+j\omega}$

b) Find and sketch the amplitude response of $H(\omega)$

c) Find and sketch the phase response of $H(\omega)$

d) Find the output y(t) when the input is $x(t)=e^{j2t}$

e) What does the output represent compared to the input

Problem 5:

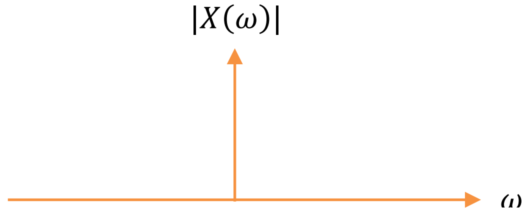
Consider the following signal which is sampled using ideal impulse train at a rate of 10 samples/second.

$$x(t) = 5 + 4\cos(8\pi t) + 6\cos(6\pi t)$$

a) For the first 3 samples fill in the following table:

	Sampling Time	***Sampled Value***
n	nT_s	$x(nT_s)$
0		
1		
2		

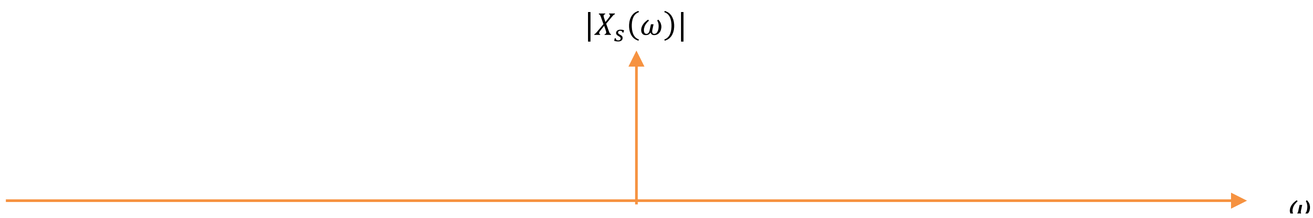
b) Find <u>and</u> sketch $X(\omega)$, which represents the frequency spectrum of $x(t)$. Show all important values on both axes.



$X(\omega) =$

c) Find <u>and</u> sketch $X_s(\omega)$, which represents the spectrum of the sampled signal $x_s(t)$.

Your sketch should show the range of frequencies $-30\pi < \omega < 30\pi \ \ rad/sec$. Show all important values on both axes.



$X_s(\omega) =$

d) What is the bandwidth of the ideal low pass filter required to reconstruct $x(t)$ from $x_s(t)$?

Problem 6:

Consider a discrete LTI system has an input $x[n]$ and output $y[n]$. When the input to the system is $x[n] = \left(\frac{1}{5}\right)^n u[n]$, the output was found to be $y[n] = \frac{5}{2}\left(\frac{1}{2}\right)^n u[n] - \frac{3}{2}\left(\frac{1}{5}\right)^n u[n]$.

a) Find the transfer function, $H(z)$, of the system.

b) Find the output of the system $y[n]$ in closed form when the input is $x[n] = \left(\frac{1}{2}\right)^n u[n]$.