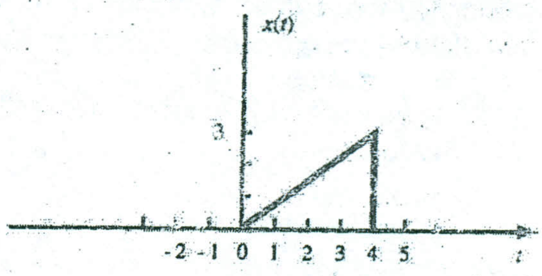
Mansoura University	**First Semester (Final Exam.)**
Faculty of Engineering	**Exam Time: 3 Hours**
Department of Electronics and Communications Engineering	**Subject: Signal Analysis**
	Course code: COM 9313
3rd Year Electronics	**Exam Date: 5-1-2012**

Attempt all questions. Assume any missed data. Full mark is 100

Q.1.a) A continuous-time signal $x(t)$ is shown in figure. Sketch and label each of the following signals:

- $x(t-2)$
- $x(2t)$
- $x(t/2)$
- $x(-t)$
- $x(n)$ if $T=1$ **[5 Marks]**



Q.1.b) Determine whether the signal $x(n) = 2 + \sin\frac{\pi n}{3} + \cos\frac{\pi n}{4}$ is periodic or not. If it is periodic, find its fundamental period. Is it an energy signal or a power signal? **[5 Marks]**

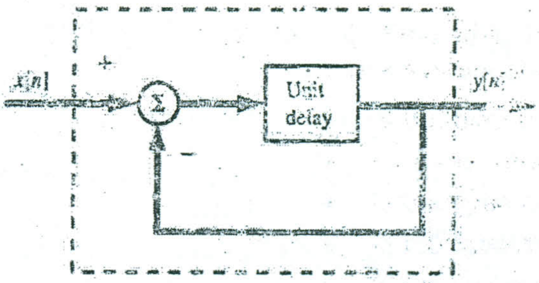
Q.1.c) Evaluate each of the following integrals:

- $\int_{-\infty}^{0} e^{-at}\delta(t-1)dt$
- $\int_{-2}^{5} 2^{t}\delta(2t-2)dt$
- $\int_{-\infty}^{\infty} \sin(2t)\delta''(t)dt$

[5 Marks]

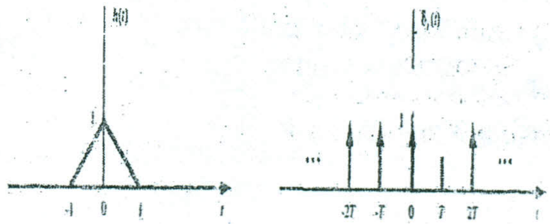
Q.1.d) Find the input-output relation of the feedback system shown.

- Is the difference equation recursive?
- Find the Impulse response of the system
- Is the system FIR or IIR?
- Is the system causal?
- Is the system stable? **[5 Marks]**



Q.1.e) The input $x(t)$ to an LTI system and the impulse response of the system are shown in the corresponding figure. Determine and sketch the output of the system when T=1.5

[5 Marks]



Q.2.a) For the transfer function $H(s) = \dfrac{se^{-3s}}{s^2 + 2.25s + 0.5}$

i. Sketch the pole-zero plot for this transfer function.
ii. What are the possible ROC's for this transfer function?
iii. For each ROC in (ii), determine stability and causality of the system.
iv. For each ROC in (ii), determine the associated impulse response. **[8 Marks]**

Q.2.b) An LTI system has a unit step response given by $(1-e^{-t})u(t)$. For a certain unknown input, *x(t)*, the output is observed to be $(2-3e^{-t}+e^{-2t})u(t)$. For this observed output, determine the true input to the system as a function of time. **[5 Marks]**

Q.2.c) Consider an LTI system described by the differential equation

$$y''(t) - y'(t) - 6y(t) = x(t), \qquad y(0) = 1, \qquad y'(0) = 0$$

i. Find the system function. Locate poles and zeros in the s-plane.
ii. Find the impulse response of the system.
iii. Find the output of the system if $x(t) = e^{t}u(t)$.
iv. What are the zero-input response and the zero-state response? **[12 Marks]**

Q.3.a) A system has the transfer function

$$H(z) = \frac{5}{1-0.7e^{j\pi/4}z^{-1}} + \frac{1}{1-0.7e^{-j\pi/4}z^{-1}} + \frac{2}{1+3z^{-1}}$$

Find the impulse response assuming the system is:

i. stable
ii. causal
iii. Can this system be both stable and causal? **[5 Marks]**

Q.3.b) Find the inverse Z-transform of each of the following functions:

i. $X(z) = \dfrac{z}{(z-1)(z-2)} \qquad 1 < |z| < 2$

ii. $X(z) = e^{a/z} \qquad |z| > 0$ **[8 Marks]**

Q.3.c) Consider a system described by

$$y(n) - 3y(n-1) = x(n), \qquad y(-1) = 1, \qquad x(n) = 4u(n)$$

i. Find the system function and locate its poles and zeros in the complex plane.
ii. Find the impulse response.
iii. Determine the output of the system.
iv. Express the output *y(n)* as a sum of two components; the zero-state response and the zero-input response. **[12 Marks]**

Q.4.a) Consider a periodic square wave *x(t)* given by:

$$x(t)=\begin{cases}8 & 0\le t\le 1\\ 0 & 1\le t\le 2\end{cases}, \qquad x(t)=x(t+2)$$

i. Find the trigonometric Fourier series of *x(t)*
ii. If *x(t)* is applied as an input to a low-pass filter with frequency response

$$H(\omega)=\begin{cases}1 & |\omega|\le 4\pi\\ 0 & |\omega|>4\pi\end{cases}$$

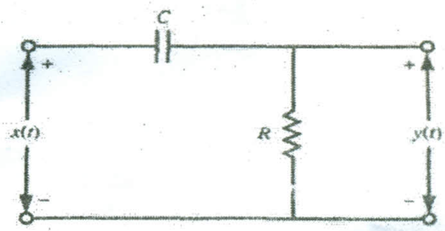
Find the output of the filter. **[7 Marks]**

Q.4.b) Consider an ideal low-pass filter given by:

$$H(\omega)=\begin{cases}1 & \omega\le\omega_c\\ 0 & \omega>\omega_c\end{cases}$$

The input to this filter is $x(t)=\dfrac{\sin(at)}{\pi t}$. Find the output *y(t)* for $a<\omega_c$. Repeat for $a>\omega_c$. Comment on results. **[5 Marks]**

Q.4.c) Derive an expression for the frequency response of the shown circuit. Sketch the magnitude and phase of the frequency response. Indicate the cut-off frequency on your sketch. Choose suitable values for *R* and *C* to realize a cut-off frequency of *10KHz*. **[5 Marks]**



Q.4.d) Sketch the Bode plot for the following frequency response

$$H(\omega)=\frac{100(1+j\omega)}{(10-j\omega/100)(1+j\omega/10)}$$

[8 Marks]

My best wishes to all of you!

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