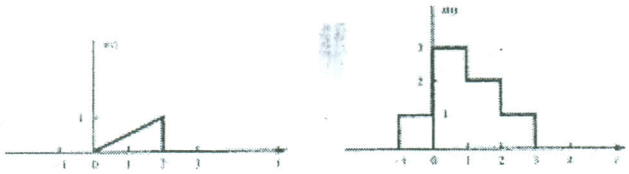
Mansoura University **Faculty of Engineering** **Department of Electronics and Communications Engineering** **3rd Year Electronics**		**First Semester (Final Exam.)** **Exam Time: 3 Hours** **Subject: Signal Analysis** **Course code: COM 9313** **Exam Date: 2-1-2013**

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

Q.1.a) Express the signals shown in terms of unit step functions **[5 Marks]**



Q.1.b) Determine whether or not each of the following signals is periodic. If a signal is periodic, determine its fundamental period. **[5 Marks]**

i. $x(t) = e^{j\pi t} + \cos(2t)$

ii. $x(n) = \cos(\frac{n}{2})\cos(\frac{\pi n}{4})$

Q.1.c) Evaluate each of the following integrals **[5 Marks]**

i. $\int_0^{2\pi} t \sin\frac{t}{2}\,\delta(\pi - t)\,dt$

ii. $\int_{-\infty}^{t} \cos(\tau)\delta(\tau)\,d\tau$

Q.1.d) A discrete-time system has an impulse response *h(n)* given by:

$$h(n) = 0.5\delta(n) + \delta(n-1) + 0.5\delta(n-2)$$

i. Plot *h(n)* versus *n*. Is the filter causal? Why?

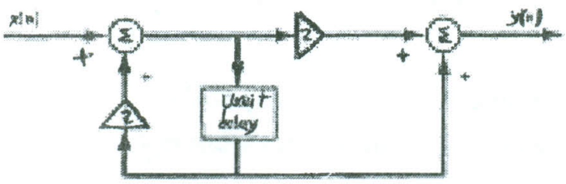
ii. Is the difference equation recursive or non-recursive?

iii. Is the filter specified by *h(n)* BIBO stable? Why?

iv. Is the filter FIR? Why? **[5 Marks]**

Q.2.a) An LTI system has an impulse response given by $e^{-3t}u(t)$. Determine the output of the system for an input, *x(t)*, given by $u(t-1)$. **[5 Marks]**

Q.2.b) Write the input-output equation for the system shown in figure **[5 Marks]**



Q.2.c) Find the inverse Laplace transform of X(s) given by

$$X(s) = \frac{2 + 2se^{-2s} + 4e^{-4s}}{s^2 + 4s + 3} \qquad -3 < \mathrm{Re}(s) < -1$$ **[5 Marks]**

Q.2.d) The step response of a continuous LTI system is give by $S(t) = 2e^{-3t}u(t)$. Find the output of the system when the input is given by $x(t) = e^{-t}u(t)$. **[5 Marks]**

Q.3.a) Consider an LTI system described by the differential equation

$$y''(t) + 5y'(t) + 6y(t) = x(t), \qquad y(0) = 2, \qquad y'(0) = 1$$

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 $x(t) = u(t)$.
iv. What are the zero-input response and the zero-state response? **[10 Marks]**

Q.3.b) Find the inverse Z-transform of each of the following functions using power series expansion: **[10 Marks]**

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

ii. $X(z) = \log\left(\dfrac{1}{1-2z^{-1}}\right) \qquad |z| > 2$

Q.3.c) Consider a system described by

$$y(n) - 5y(n-1) + 6y(n-2) = x(n), \qquad y(-1) = 3, \qquad y(-2) = 2, \quad x(n) = u(n)$$

i. Find the system function and locate its poles and zeros in the complex plane.
ii. Determine the output of the system.
iii. Express the output *y(n)* as a sum of two components; the zero-state response and the zero-input response. **[10 Marks]**

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

$$x(t) = \begin{cases} 10 & 0 \le t \le 1 \\ 0 & 1 \le t \le 2 \end{cases}, \qquad x(t) = x(t+2)$$

i. Sketch *x(t)*. State the conditions required for the convergence of Fourier series.
ii. Find the complex exponential Fourier series of *x(t)*.
iii. Use the result of (ii) to get the trigonometric Fourier series of *x(t)*.
iv. If *x(t)* is applied as an input to a high-pass filter with frequency response

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

Find the output of the filter. **[15 Marks]**

Q.4.b) An ideal phase shifter is represented by the following equation

$$H(\omega) = \begin{cases} e^{-j\frac{\pi}{2}} & \omega > 0 \\ e^{j\frac{\pi}{2}} & \omega < 0 \end{cases}$$

i. Find the impulse response *h(t)* of this phase shifter.
ii. Find the output *y(t)* when the input is $x(t) = \cos\omega_o t$ **[5 Marks]**

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

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

My best wishes to all of you!

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