Mansoura University Faculty of Engineering Department of Electronics and Communications Engineering 3rd Year Electronics	Open Book Exam	First Semester (Final Exam.) Exam Time: 3 Hours Subject: Signal Analysis Course code: COM 9313 Exam Date: 5-1-2014

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

Q.1.a) Correct the errors, if any, in each of the following statements **[10 Marks]**

i. The system described by $h(n) = 3^n u(n)$ is stable.

ii. The system described by $y(n) = anx^2(n)$ is time invariant.

iii. The signal $x(t) = u(t-2)$ is a power signal.

iv. The system described by $y = 2x + 3$ is linear.

v. The system described by $h(t) = -\delta(-t) + \delta(3t)$ is memoryless.

vi. The signal $x(n) = \sin 2n + \cos 4n$ is periodic with fundamental period π.

vii. The signal $x(n) = \cos \Omega_o n u(n)$ is periodic.

viii. Any continuous-time signal, *x(t)*, can have Fourier series representation.

ix. In distortionless transmission, both amplitude and phase of the frequency response must be constant over the entire frequency rang.

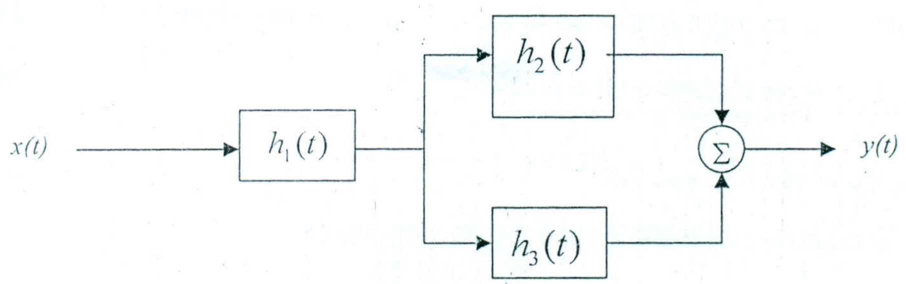
x. A signal is band-limited if $|X(\omega)| = 0 \quad for \quad |\omega| < \omega_M$

Q.1.b) An interconnection of LTI system is shown below. The impulse responses are:

$$h_1(t) = 2u(t-1) - 2u(t-3), \quad h_2(t) = \delta(t) - \delta(t-2), \quad h_3(t) = \delta(t-1) + \delta(t-2)$$

i. Express the impulse response of the overall system, *h(t)*, in terms of $h_1(t), h_2(t)$, and $h_3(t)$. Evaluate *h(t)* and determine whether the system corresponding to *h(t)* is stable and causal.

ii. If $x(t) = 2\delta(t-4)$, find the output, y(t). **[10 Marks]**



Q.2.a) For the transfer function $H(s) = \dfrac{s+2}{s^2 + 4s - 5}$

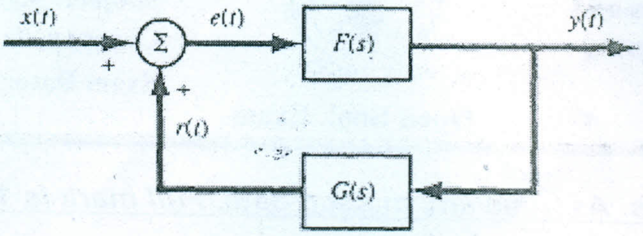
i. Sketch the pole-zero plot for this transfer function.

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 inverse transform. **[10 Marks]**

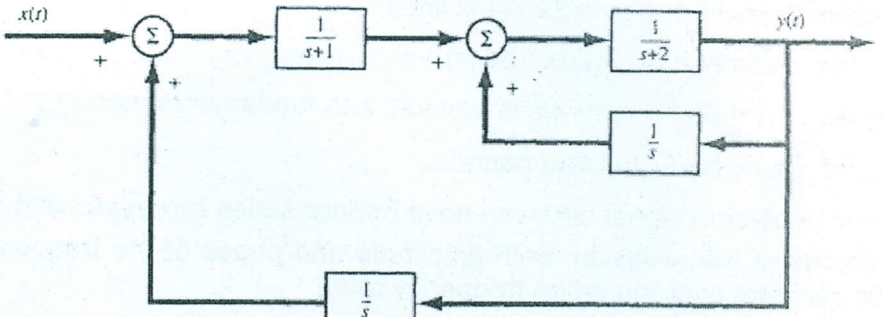
Q.2.b) The feedback interconnection of two causal subsystems with system functions *F(s)* and *G(s)* is depicted in the shown figure. **[10 Marks]**



Show that the overall system function H(s) for this feedback system is given by:

$$H(s) = \frac{F(s)}{1 - F(s)G(s)}$$

Use the result to determine the overall system function *H(s)* for the system shown below.



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

$$y''(t) - 4y(t) = x(t), \qquad y(0) = 1, \qquad y'(0) = 1$$

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) A digital filter is described by the following system function:

$$H(z) = \frac{z(z-1)}{z^2 - 2.5z + 1}$$

Find the impulse response of the filter in the following cases:

i. $|z| > 2$ ii. $|z| < 0.5$

In each case, verify the first three terms of your answer using power series expansion method. **[10 Marks]**

Q.4.a) Consider a system described by

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

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

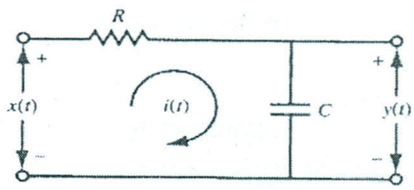
$$x(t) = \begin{cases} 10 & 0 \le t \le 2 \\ 0 & 2 \le t \le 4 \end{cases}, \qquad x(t) = x(t+4)$$

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

$$H(\omega) = \begin{cases} 1 & |\omega| \ge 8\pi \\ 0 & |\omega| < 8\pi \end{cases}$$

Find the output of the filter. **[10 Marks]**

Q.5.a) 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.5.b) A system is described by the frequency response

$$H(\omega) = \begin{cases} e^{-j\pi/4} & |\omega| < \pi/3 \\ 0 & |\omega| > \pi/3 \end{cases}$$

i. Determine the impulse response *h(t)* of this filter.
ii. Calculate the output of the system if the i/p is $x(t) = \cos(\frac{\pi}{6}t + 0.4\pi)$ **[5 Marks]**

Q.5.c) Sketch the Bode plot for the following frequency response

$$H(\omega) = \frac{1000(1+j\omega)}{j\omega(100+j\omega)}$$

[10 Marks]

My best wishes to all of you!

Assis. Prof. Hossam El-Din Moustafa