Analog and Digital Signal Processing
Course Code: CSE363
Fall Semester Exam.

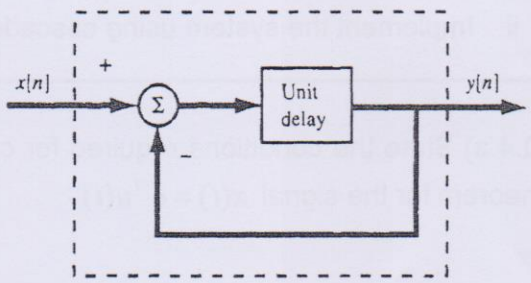
BME Program
Level 300
Exam Date: 5-1- 2017
Allowed Time: 2 Hours

Open-Sheet Exam

Attempt all questions. Assume any missed data. Full mark is 50.

Q.1.a) Determine whether the signal $x(n) = \sin 10\pi t + \cos 5\pi t$ 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.b) Find the input-output relation of the feedback system shown.



i. Is the difference equation recursive?
ii. Find the Impulse response of the system
iii. Is the system FIR or IIR?
iv. Is the system causal?
v. Is the system stable? **[5 Marks]**

Q.1.c) Consider a continuous-time LTI system with the input-output relation given by

$$y(t) = \int_{-\infty}^{t} e^{-(t-\tau)} x(\tau) d\tau$$

i. Find the impulse response of the system

ii. Show that the complex exponential function e^{st} is an eigen-function of the system and find the corresponding eigen-value. **[5 Marks]**

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

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

i. Find the system function.
ii. Find the impulse response of the system.
iii. Find the output of the system if $x(t) = e^{-t}u(t)$. **[5 Marks]**

Q.2.b) Find the inverse Z-transform the following function using partial fraction method. Verify your result using power series expansion. **[5 Marks]**

$$X(z) = \frac{z^2}{z^2 - 5z + 6} \qquad |z| > 3$$

Q.2.c) Consider a system described by

$$y(n)-2y(n-1)=x(n), \quad y(-1)=2, \quad , \quad x(n)=3u(n)$$

i. Determine the output of the system.
ii. Express the output *y(n)* as a sum of two components; the zero-state response and the zero-input response. **[5 Marks]**

Q.3.a) Design a digital high-pass filter with cut-off frequency of 0.7π rad. The transition band is 0.5π rad. The minimum stop-band attenuation is 20 dB. **[5 Marks]**

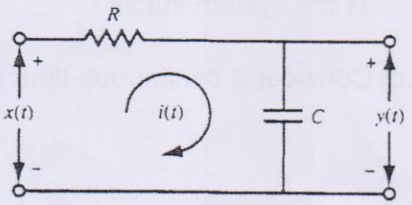
Q.3.b) A system is represented by its transfer function H(z) given by:

$$\frac{(z^2+1)(z^2-2z-1)}{(z^2+z+1)(z^2+3z+4)}$$

i. Implement the system using canonical form.
ii. Implement the system using cascade realization **[5 Marks]**

Q.4.a) State the conditions required for convergence of Fourier transform. Verify Parseval's theorem for the signal $x(t)=e^{-t}u(t)$ **[5 Marks]**

Q.4.b) Derive an expression for the frequency response of the shown circuit. Sketch the magnitude 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 *1KHz*. **[5 Marks]**



Q.4.c) Given *x(n)={0, 0, 1, 1}* and *H(k)={6, -2+j2, -2, -2-j2}*

i. Find *X(k)* " The DFT of *x(n)* "
ii. Find *h(n)* " The IDFT of H(k) "
iii. Find $y(n)=x(n)\otimes h(n)$ **[5 Marks]**

My best wishes to all of you!

Assoc. Prof. Hossam El-Din Moustafa