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

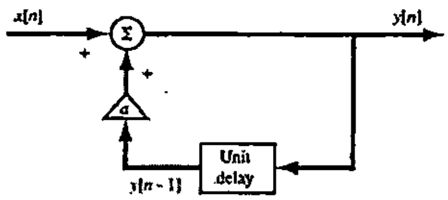
BME Program
Level 300
Exam Date: 28-12- 2019
Allowed Time: 2 Hours

**Open-Sheet Exam**

يمنع الإجابة بالقلم الرصاص – يراعى حسن تنسيق ورقة الإجابة

***<u>Attempt all questions. Assume any missed data. Full Mark is 50</u>***

**Q.1)** For the system shown: **[5 Marks]**




a. Find the impulse response.

b. Classify the system according to causality, memory, stability, recursiveness, IIR or FIR??

**Q.2)** The impulse response h(t) of a continuous-time LTI system are given by:

$$h(t) = 2e^{-t}u(t)$$

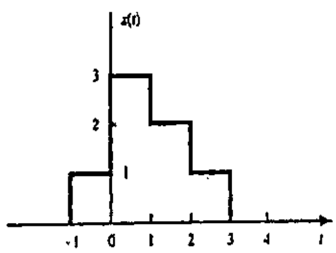
Find the output of the system corresponding to the following inputs **<u>(Solve in time domain)</u>**

i. $x(t) = e^{-3t}u(t)$

ii. $x(t) = u(t/2)$

iii. $x(t) = \delta(3t - 3)$ **[6 Marks]**

**Q.3)** For the signal shown in the following figure




a. Express the signal shown in terms of unit step functions.

b. Is $x(t)$ power or energy signal?

c. Find the odd and even components of $x(t)$.

d. Sketch and label each of the following signals.

$(i) x(t)u(1-t)$; $(ii) x(t)(u(t+2) + u(t))$;
$(iii) -x(t)\delta(3t+6)$; $(iv) x(t)u(3t)$ **[6 Marks]**

**Q.4)** An ideal radian phase shifter is defined by the following frequency response

$$h(\omega) = \begin{cases} 2\, e^{-j\left(\frac{3\pi}{4}\right)} & \omega > 0 \\ 2\, e^{j\left(\frac{3\pi}{4}\right)} & \omega < 0 \end{cases}$$

a. Find the impulse response $h(t)$ of this phase shifter.

b. Find the output $y(t)$ of this phase shifter due to an arbitrary input $x(t)$.

c. Find the output $y(t)$ when $x(t) = \sin\frac{\pi}{3}t$ **[5 Marks]**

**Q.5)** A low pass filter (LPF) with an amplification factor of 3, with phase shift ($-\frac{3\pi}{4}$) and with cut off frequency of $\frac{\pi}{2}$.

a. Find the frequency response of this LPF corresponding to the previous specifications
b. Find the impulse response of the resulting low pass filter
c. Find the output of the LPF corresponding to the input $x(t) = 3\sin \pi t$ **[5 Marks]**

**Q.6)** Consider an LTI system described by the differential equation

$$y'(t) + 4y(t) = x(t), \qquad y(0) = 2$$

i. Find the system function.
ii. Find the impulse response of the system. **[5 Marks]**

**Q.7)** Find the inverse Z-transform the following function using partial fraction method. Verify your result using power series expansion. **[5 Marks]**

$$X(z) = \frac{z}{z^2 - 3/2z + 1/2} \qquad |z| > 1$$

**Q.8)** Consider a system described by

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

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.9)** The system function of a discrete-time system is given by

$$H(z) = \frac{4}{1 - e^{-0.4} z^{-1}} + \frac{4}{1 - e^{-0.8} z^{-1}}$$

If H(z) was designed using bilinear transformation with T=2. Find the system function H(s) of the continuous-time filter that could have been the basis for the design. **[5 Marks]**

**Q.10)** An FIR low-pass filter is approximated by the ideal frequency response:

$$H_d(e^{jw}) = \begin{cases} e^{-j2\omega} & 0 < |\omega| < \pi/4 \\ 0 & \pi/4 < |\omega| < \pi \end{cases}$$

Use *Hanning window* with length N=5 to get the FIR filter impulse response $h_d(n)$. Find the system function of the resulting filter.

***Hint:*** $W_{Han}(n) = \begin{cases} 0.5 - 0.5\cos\frac{2\pi n}{N-1} & 0 \le n \le N-1 \\ 0 & elsewhere \end{cases}$ **[5 Marks]**

**Q.11)** A system is represented by its transfer function H(z) given by:

$$\frac{(z^2+2z+3)(z^2+4z+5)}{(z^2+z+1)(z^2+4)}$$

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

*Best wishes to all of you!*

*Assoc. Prof. Hossam El-Din Moustafa*

*Assis. Prof. Doaa Adel*