King Saud University
College of Engineering
Electrical Engineering Department

EE301: Signals and System Analysis

Final Exam

Instructors: **A. Sheta & S. Aldosari**

Date: **21/5/1428**

Time: **8:00-11:00 pm**

Question	Mark
1	
2	
3	
4	
5	
6	
Total Mark	

	اسم الطالب:
	الرقم الجامعى:
	الشعبة :
	مسلسل :

Problem I (20 points)

(a) Determine whether or not each of the following signals is periodic. If the signal is periodic find the fundamental period.

i. $x_1(t) = 3\cos 2\pi t^2$

ii. $x_2[n] = e^{j\frac{3\pi}{4}n} + e^{-j\frac{5\pi}{2}n}$

(b) the signal $x_3(t)$ is defined by $x_3(t) = \begin{cases} -\frac{1}{4}t + 1 & 0 < t < 2 \\ 0 & otherwise \end{cases}$

i. sketch the signal $x_3(2t-1)$

ii. find the energy and power in the signal $x_3(t-5)$

(c) Discuss the invertible and linear time invariant properties of the signals:

i. $y(t) = x^2(t)$ ii. $y[n] = x[2n] + 1$

Problem II (20 points)

(a) The impulse response of an LTI system is given as $h(t) = 3e^{-|t|}u(t)$

Find the output y(t) if the input is $x(t) = e^{-|t|}$

(b)

i. The unit step response can be used to characterize an LTI system. Derive an expression that relates the impulse response to unit step response for DT system.

ii. find the unit step response s[n] of an LTI system where its impulse response is given by

$$h[n] = (\frac{1}{2})^{n-1} u[n-1]$$

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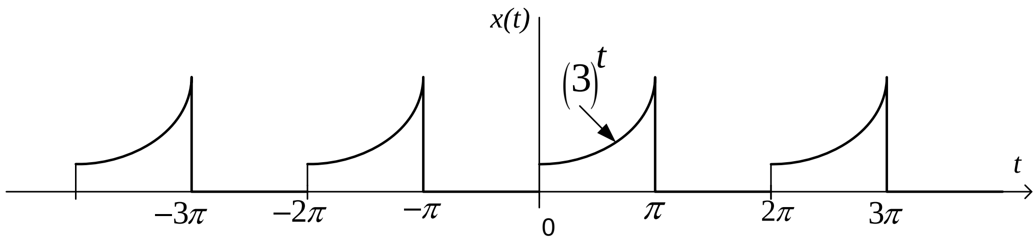
Problem III (20 points)

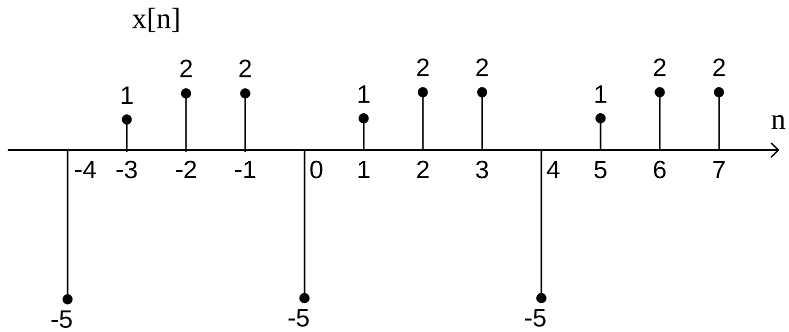


(a) For the above continuous-time periodic signal:

(i) Find the Fourier series coefficients a_k of $x(t)$

(ii) Find the dc component of $x(t)$

Hint: $\int a^u du = \frac{1}{\ln(a)} a^u$



(b) For the above discrete-time periodic signal:

(i) Find the **4th harmonic** component of $x[n]$

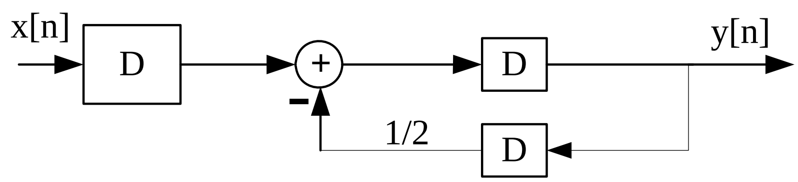
(ii) Find the **8th harmonic** component of $x[n]$. What is the relationship between the 4th and the 8th harmonic components? Explain why?

Problem IV (20 points)

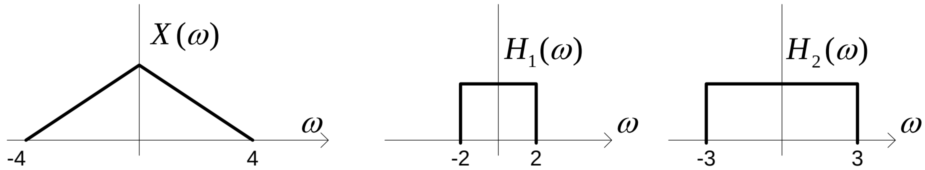
(a) The Fourier transform of $x(t) = e^{-t^2/2}$ is given by $X(\omega) = \sqrt{2\pi}\, e^{-\omega^2/2}$.

Using this information find $y(t)$ the inverse Fourier transform of $Y(\omega) = \omega\, e^{-\omega^2/2}$.

(b) Find the frequency response $H(e^{j\omega})$ of the following discrete-time system:



Problem V (20 points)

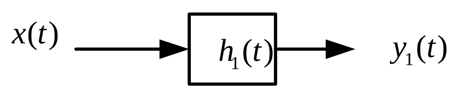


Let $X(\omega), H_1(\omega), H_2(\omega)$ be the Fourier transforms of $x(t), h_1(t), h_2(t)$ respectively. In the following questions <u>choose the correct answers</u> and <u>**explain why**</u>?

(a) Suppose that the signal $x(t)$ is sampled at a sampling angular frequency $\omega_s = 9$, what should be the **cutoff-frequency** ω_c of the reconstruction filter to reconstruct the original signal?

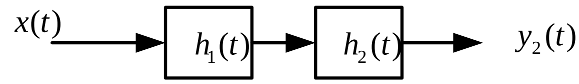
(i) $\omega_c > 8$ (ii) $\omega_c < 8$ (iii) $\omega_c > 4$ (iv) $\omega_c < 4$ (v) $\omega_c > 3$ (vi) $\omega_c < 3$
(vii) $\omega_c > 0$ (viii) $3 < \omega_c < 4$ (ix) $4 < \omega_c < 5$ (x) $5 < \omega_c < 6$ (xi) $2 < \omega_c < 4$ (xii) $4 < \omega_c < 8$

(b) In the following system we would like to sample the signal $y_1(t)$. What is the minimum sampling angular frequency ω_s?



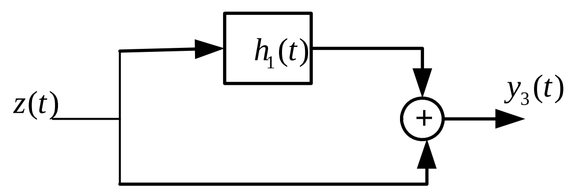
(i) 0 (ii) 1 (iii) 2 (iv) 3 (v) 4 (vi) 5
(vii) 6 (viii) 7 (ix) 8 (x) 9 (xi) 10 (xii) 2/3

(c) In the following system we would like to sample the signal $y_2(t)$. What is the minimum sampling angular frequency ω_s ?



(i) 0	(ii) 1	(iii) 2	(iv) 3	(v) 4	(vi) 5
(vii) 6	(viii) 7	(ix) 8	(x) 9	(xi) 10	(xii) 2/3

(c) In the following system **the input** is $z(t) = x\left(\frac{3}{4}t\right)$ and we would like to sample the signal $y_3(t)$. What is the minimum sampling angular frequency ω_s ?



(i) 3/4	(ii) 1	(iii) 2	(iv) 3	(v) 4	(vi) 5
(vii) 6	(viii) 7	(ix) 8	(x) 16/3	(xi) 10	(xii) 4/3

Problem VI (20 points)

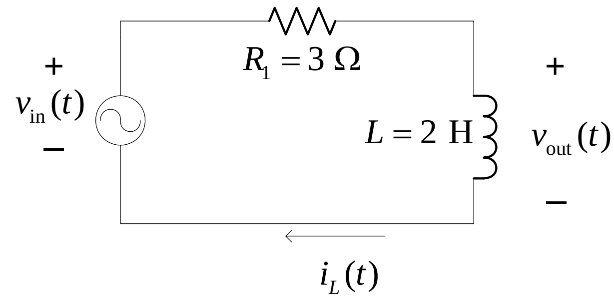
(a) The transfer function of a continuous-time system is given by

$$H(s) = \frac{7(s-3)}{(s+1)(s^2-6s+8)}$$

(i) Sketch the zero-pole plot and find all possibilities for the region of convergence (ROC).

(ii) For each ROC **discuss** the causality and stability of the system.

(iii) For each ROC find the impulse response $h(t)$ of this system.



(b) In the following circuit, assume that $v_{in}(t) = 0$ for t<0.

i) Find the transfer function of this system $H(s) = \dfrac{V_{out}(s)}{V_{in}(s)}$.

ii) sketch the zeros-pole plot of this system showing the ROC (this is a causal system)