MKT 2812 Signals and Systems

Name: _____
ID:_____
Group: _____
Date: June 15, 2021
Exam Time: 15:00-17:30

Total	1	2	3	4	5

1) This is an open-note, book and Matlab/Simulink/Python exam to be uploaded to UZEM platform on time.

2) Don't need to answer all questions, just for 100 points.

3) **Submissions**: Single readable PDF file named as "`YTU-ID_Lastname_MKT2812.pdf`" must be submitted. For example, `206A0123_Yesildirek_MKT2812.pdf`
For any unforeseen reason if you cannot upload the file to UZEM (Attach the error screenshot)
   - You may use `classroom.google.com`
   - If classroom.google.com is crashed for some reason, send an email (prove it by an attached screenshot) to `aydiny@yildiz.edu.tr`

   Otherwise, you will be assumed to be absent.

4) Each question must start on a numbered new blank white page ordered according to question numbers.

5) Academic Honesty Statement:

For this take-home exam, I make the following truthful statements:

- I have not received, I have not given, I have not discussed, nor will I give or receive, any assistance to another person durıng this exam.
- I will not plagiarize someone else's work and turn it in as my own.
- I will not send a copy of the exam and publish it in other mediums. I acknowledge that this exam belongs to the YTU Mechatronics Department.
- I understand that acts of academic dishonesty may be penalized to the full extent allowed by the YOK Student Conduct Code (Öğrenci Disiplin Yönetmeliği).
- I recognize that any violation of these statements without an expressed permission is considered academic misconduct.

Handwrite the consent of the rules stated in Turkish below and sign it at the beginning of your final exam paper.

YOUR FIRST PAGE

"Final sınavı için kapakta belirtilen kuralları okudum, anladım, ve kabul ediyorum.

Ad-Soyad
Student ID

İ*mza*"

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1) [25 pts.] Answer the following signal questions

a) (5 pts.) Plot the odd part of the signal $x[n]$ shown

b) (5 pts.) Let the signals be

$$x[n] = 2\cos[5n], \quad y[n] = \sin(3\pi n) + 1, \quad z[n] = x[n] + 2y[n]$$

What are the fundamental period these signals, if they are periodic?

c) (5 pts.) Given

$$x[n] = 4r[n+2] - 4r[n] - 4u[n-2] - 4r[n-4] + 4r[n-5]$$

Find and sketch $y[n] = x[2n-4]$

d) (10 pts) Ideal low pass filter's, with cutoff frequency of 1 kHz , output is sampled at 1.5 kHz. Plot magnitude frequency spectrum of the sampler output if the filter input is given by

i) $x_1(t) = 2\cos(1000\pi t)$

ii) $x_1(t) = 2\cos(4000\pi t)$

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2) [25 pts.] In a round theater where the orchestra is in the middle of two concentric circles and the walls on one half side are at a radial distances of 15 m (corresponding to the inner circle), and 30 m (corresponding to the outer circle) on the other side from the orchestra. The speed of sound is 350 m/s. Assume that the recorded signal is the sum of the original signal y[n], and attenuated by $0.95e^{-0.003d}$ (d distance wave travels) echo signals from the two walls. Use the handle.mat Matlab file for the sampling time and raw sound data to illustrate your work.
   a) (5 pts.) Let the input of the system be the sound generated by the orchestra and the output be the total sound recorded at the center of the theater. Find a representation of this system as an impulse response $h[n]$.
   b) (10 pts.) Analyze the linearity, time-invariance, BIBO stability and causality of the system.
   c) (10 pts.) Find its step response using the convolution sum,

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3) [25 pts.] Find the Fourier series representation of $x(t)$ with the first period signal

$$x_1(t) = 4u(t+1) - 5u(t-3) + u(t-4)$$

Show the magnitude line spectrum.

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4) (25 pts) Using the Fourier transform pair

$$u(t+T)-u(t-T) \overset{\text{FT}}{\Leftrightarrow} 2T\frac{\sin \Omega T}{\Omega T}$$

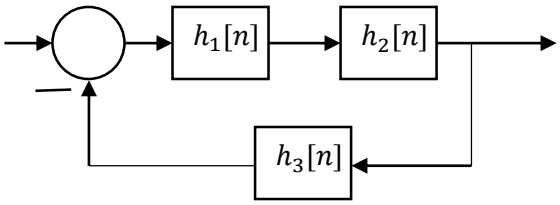
And FT properties, compute the Fourier transforms of

a) $x_1(t) = -u(t+3) + 2u(t+1) - u(t-1)$
b) $x_2(t) = u(2t-4) - u(2t+4)$
c) $x_3(t) = \sin(\omega_o t)/t$

Table 5.1 Basic properties of the Fourier transform

Expansion/contraction	$x(\alpha t), \alpha \neq 0$	$\frac{1}{\lvert\alpha\rvert} X\left(\frac{\Omega}{\alpha}\right)$
Reflection	$x(-t)$	$X(-\Omega)$
Parseval's	$E_x = \int_{-\infty}^{\infty} \lvert x(t)\rvert^2 dt$	$E_x = \frac{1}{2\pi}\int_{-\infty}^{\infty} \lvert X(\Omega)\rvert^2 d\Omega$
Duality	$X(t)$	$2\pi x(-\Omega)$
Differentiation	$\frac{d^n x(t)}{dt^n}, n \geq 1$	$(j\Omega)^n X(\Omega)$
Integration	$\int_{-\infty}^{t} x(t')dt'$	$\frac{X(\Omega)}{j\Omega} + \pi X(0)\delta(\Omega)$
Shifting	$x(t-\alpha), e^{j\Omega_0 t}x(t)$	$e^{-j\alpha\Omega}X(\Omega), X(\Omega-\Omega_0)$
Modulation	$x(t)\cos(\Omega_c t)$	$0.5[X(\Omega-\Omega_c) + X(\Omega+\Omega_c)]$
Periodic	$x(t) = \sum_k X_k e^{jk\Omega_0 t}$	$X(\Omega) = \sum_k 2\pi X_k \delta(\Omega - k\Omega_0)$
Symmetry	$x(t)$ real	$\lvert X(\Omega)\rvert = \lvert X(-\Omega)\rvert$, $\angle X(\Omega) = -\angle X(-\Omega)$
Convolution	$z(t) = [x * y](t)$	$Z(\Omega) = X(\Omega)Y(\Omega)$

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5) (25 pts.) DT LTI system with subsystems' impulse responses

$$h_1[n] = 2\delta[n], \quad h_2[n] = 0.2^n u[n-2], \quad h_3[n] = (-0.5)^n u[n]$$

What is the step response?

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