BIMU3009
Signal Processing
Midterm Exam

Istanbul University - Cerrahpaşa
Computer Engineering Department - FALL 2020

Due by November 25$^{\text{th}}$, 2020 10:00

PLEASE READ

Submission: After finishing the exam, <u>**you must put your name, number and signature on every page**</u> on your answer sheet and use a mobile tool like **Microsoft Office Lens** or a similar Document scanner to scan your solutions (or scan using a desktop scanner) and create a single PDF file. DO NOT just take pictures and merge them, background must not be visible.

Name your file in the following fashion, where you will replace `1306XXXX` with your actual school number:
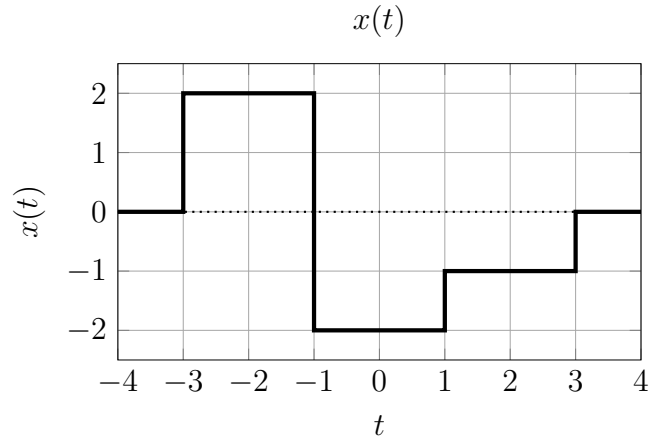
`signal-2020-midterm-1306XXXX.pdf`

You must upload the file to MERGEN by the deadline.

YOU MAY USE COMPUTER TOOLS and ONLINE TOOLS LIKE WOLPHRAM ALPHA TO CALCULATE THE RESULTS.

Good Luck. (Mustafa Dağtekin)

Q1: Consider the following CONTINUOUS TIME signal. Answer the following questions.

$x(t)$

(a) (10 pts) Write $x(t)$ as weighted superposition of step functions.

(b) (15 pts) Carefully sketch $2\,x(0.5t - 0.5) + 3\,x(2t + 1)$.

(c) (15 pts) Calculate the average power and total energy of $x(t)$. Is $x(t)$ an energy signal, power signal or neither?

Q2: For the DT LTI system $\mathcal{H}_3$, the impulse response is given as:

$$h[n] = \begin{cases} 0 , & n < 3 \\ n \left(\dfrac{1}{4}\right)^n , & 3 \leq n \end{cases}$$

Answer the following questions.

(a) (20 pts) Find the output of this system when the input is the following:

$$x[n] = 2^{-n}\, u[4 - n]$$

Hint (İPUCU): (Assuming $a, b \in \mathbf{Z}, 0 < a < b, 0 < \beta < 1$)

$$\sum_{x=a}^{b} x\, \beta^x = \frac{\beta^{b+1}\,(\beta\, b - b - 1) \; - \beta^a\,[(a - 1)\beta - a]}{(\beta - 1)^2}$$

$$\sum_{x=a}^{\infty} x\, \beta^x = \frac{\beta^a\,[a - (a - 1)\beta]}{(\beta - 1)^2}$$

(b) (5 pts) Is $\mathcal{H}_3$ stable? Show your work.

(c) (2 pts) Is $\mathcal{H}_3$ memoryless? Explain.

(d) (3 pts) Is $\mathcal{H}_3$ causal? Explain.

Q3: Consider the following DT system. Answer the following questions.

$$y[n] = \mathcal{H}_2\{x[n]\} = e^{n+1}\, x[n - 1]$$

(a) (10 pts) Is $\mathcal{H}_2$ stable? Show your work.

(b) (10 pts) Is $\mathcal{H}_2$ linear? Show your work.

(c) (10 pts) Is $\mathcal{H}_2$ time invariant? Show your work.