BIMU3009
Signal Processing
Homework # 4

Istanbul University - Cerrahpaşa

Computer Engineering Department - FALL 2022

Due by October 25$^{\text{th}}$, 2022 23:59

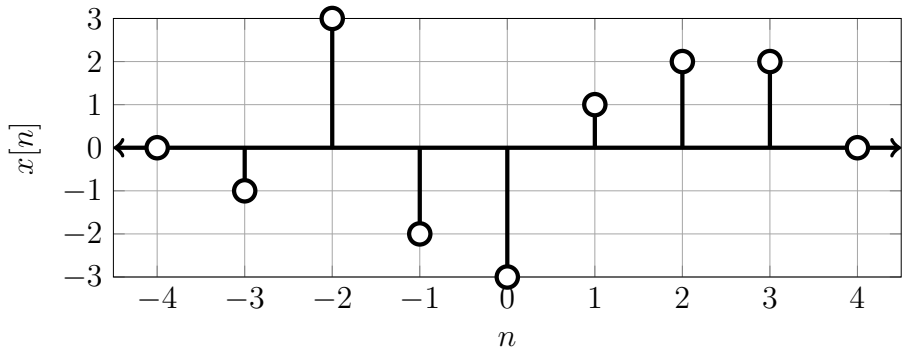
Bu ödevde sorulan soruları bir kağıda veya defterinize çözüp tek dosya halinde Canvas sistemine tek dosya PDF olacak şekilde bitiş süresinden önce yükleyiniz. Yükleme için kendinize süre ayırınız, saatinden sonra yapılan yüklemeler kesinlikler kabul edilmeyecektir.

QUESTIONS

Q1: A CT signal, $x(t)$, is periodic with a fundamental period T. Show that the following is true for any $\alpha < \beta \quad \alpha, \beta \in \mathbb{R}$

$$\int_{\alpha}^{\beta} x(t)\,\mathrm{d}t = \int_{\alpha+T}^{\beta+T} x(t)\,\mathrm{d}t$$

Q2: Consider the following DISCRETE TIME signal. Answer the following questions.



(a) Step by step, sketch $2\,x[2n+1]$. Show your work.

(b) Step by step, sketch $3\,x[n] \cdot u[1-n]$. Show your work.

Q3: Evaluate the following integrals.

(a) $\int_{-1}^{2} (1 - 2t)\ \delta(t)\ \mathrm{d}t$

(b) $\int_{-\infty}^{\infty} \mathrm{e}^{-t}\ \delta(2t - 4)\ \mathrm{d}t$

Q4: `(10 pts)` Determine whether the following signal is periodic. If it is, determine its fundamental period. Show your work.

$$x(t) = \cos\left(\frac{2\pi}{3}t + \frac{2\pi}{3}\right) + \sin\left(\frac{2\pi}{7}t + \frac{3\pi}{5}\right)$$

Q5: Consider the following signal. Answer the following questions.

$$x(t) = u(t + 10) - 2\ u(t + 3) + u(t - 4)$$

(a) Carefully sketch $x(t)$. Show your work.

(b) Find and sketch the following signal, show your work.

$$z(t) = \frac{\mathrm{d}}{\mathrm{d}t}\ x(t)$$

Q6: `(10 pts)` Carefully sketch the following signal. Show your work.

$$x[n] = u[n + 10] - 2\ u[n + 3] + u[n - 4]$$

Q7: A CT system, $\mathcal{H}$, is defined by the following input-output relationship:

$$y(t) = \mathcal{H}\{x(t)\} = x(t) \cdot \cos(\omega t)$$

Determine if $\mathcal{H}$ is stable, linear, causal, memoryless and time-invariant.

Q8: Consider the systems represented by input-output relationships below. Determine if they are invertible and if they are, find the inverse system.

(a) $y(t) = 2x(t)$

(b) $y[n] = 3x^3(t)$

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

(d) $y[n] = n\ x[n]$