EC5.101 - Network, Signals and Systems
Assignment 2

Release date: 30 Aug 2023 | Due date: 07 Sep 2023

Instructions:

1. The handwritten assignment must be submitted individually.
2. Students are free to refer to class notes and textbooks. Discussions are allowed but copying and plagiarism will attract strict penalty.
3. Late submission: 10 % penalty per day (up to at most 3 days after deadline).
4. Mention any additional assumptions you make that is not given in the question.
5. Clearly show the steps used to arrive at the solutions.

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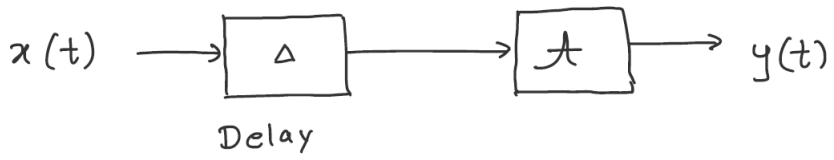
1. [12 marks] Consider the system with input signal $x(t)$ and output signal $y(t)$ shown below.



Here $\mathcal{A}$ denotes the integrator block. Let the amount of delay be $\Delta = 3$. Answer the following:

(a) [3] Find the impulse response of this system.

(b) [2] Is this system linear? Prove your answer.

(c) [2] Is this system time-invariant? Prove your answer.

(d) [5] Find and sketch the output of this system for the following input signals:

i. $x(t) = \delta(t) - \delta(t-1)$

ii. $x(t) = u(t) + u(t-1)$

2. [10 marks] A periodic signal with period $T = 1$ is given as follows:

$$x(t) = \delta(t - 0.5),\ 0 \leq t \leq 1.$$

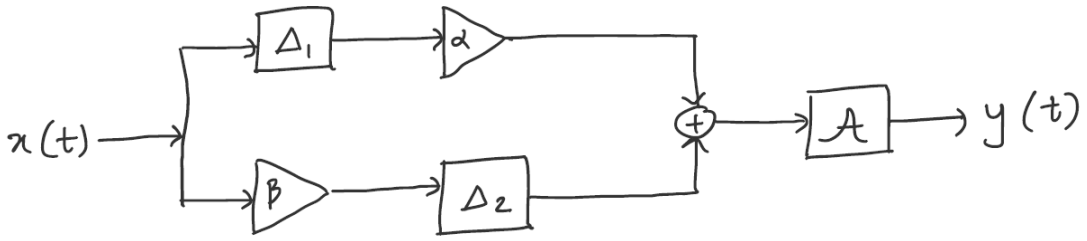
(a) [2]Sketch the above signal.

(b) [8] Find all the complex Fourier series coefficients for this signal. Give simplified answers.

3. [10 marks] Consider the system with input signal $x(t)$ and output signal $y(t)$ shown below. Here $\mathcal{A}$ denotes the integrator block. It also consists of scaling blocks with parameters α and β and delay blocks with parameters Δ_1 and Δ_2. Answer the following:

   (a) [5] Find the mathematical relation between input signal $x(t)$ and output signal $y(t)$.

   (b) [5] Analyse whether changing the order of the delay and scaling blocks affects the input output relationship.



4. [8 marks] A system with input signal $x(t)$ and output signal $y(t)$ is given by

$$y(t) = \int_{-\infty}^{t} x^2(\tau) d\tau, \quad \forall t \in \mathbb{R}.$$

   (a) Investigate this system properties in terms of linearity, time-invariance, and causality.

   (b) Find and plot the output of this system when the input is a step signal $u(t)$.