MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING

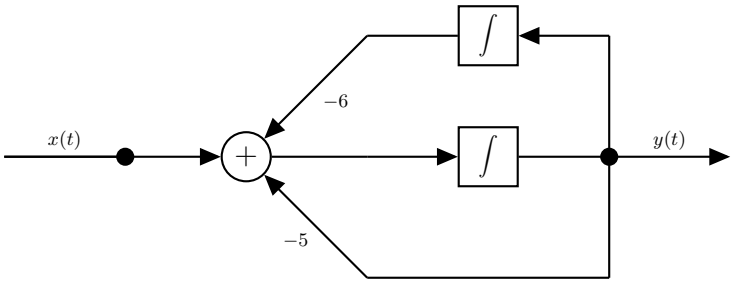
CENG 384

Spring 2021
Homework 2

Regulations:

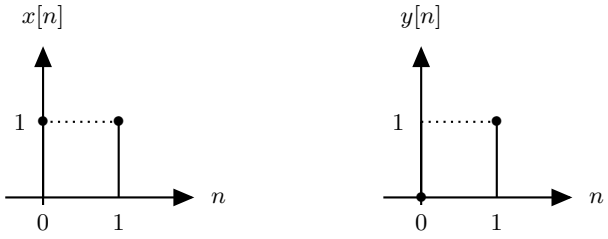
- **Grouping:** You are allowed to work in pairs.
- **Submission:** We provide a latex template for your solutions. Use that template and create a hw2.tar.gz file that includes hw2.tex and all other related files. Tar.gz file should not contain any directories and should create a *hw2.pdf* file with the following commands, otherwise you will get zero;
  tar xvzf hw2.tar.gz
  pdflatex hw2.tex
  Submit hw2.tar.gz to the odtuclass page of the course.
- **Deadline:** 23:55, 27 April, 2021 (Tuesday).
- **Late Submission:** Not allowed.

1. (15 pts) Consider an LTI system given by the following block diagram:

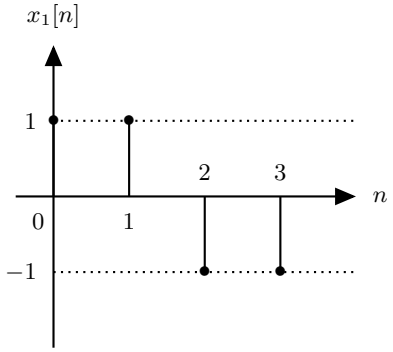


   (a) (5 pts) Find the differential equation which represents this system.
   (b) (10 pts) Find the output $y(t)$, when the input $x(t) = (e^{-t} + e^{-4t})u(t)$. Assume that the system is initially at rest.

2. (20 pts) Consider a discrete LTI system, initially at rest, given by the following input-output pair:



   (a) (5 pts) Find the output of this system for the following input: (Hint: Use superposition and time invariance property.)



   (b) (5 pts) Find and plot the impulse response of this system.
   (c) (5 pts) Find the difference equation which represents this system.
   (d) (5 pts) Find the block diagram representation of this system.

3. (10 pts) Evaluate the following convolutions.
   (a) (5 pts) Given $x[n] = \delta[n-3] + 2\delta[n+1]$ and $h[n] = \delta[n-1] + 3\delta[n+2]$, compute and draw $y[n] = x[n] * h[n]$.
   (b) (5 pts) Given $x[n] = u[n+3] - u[n]$ and $h[n] = u[n-1] - u[n-3]$, compute and draw $y[n] = x[n] * h[n]$.

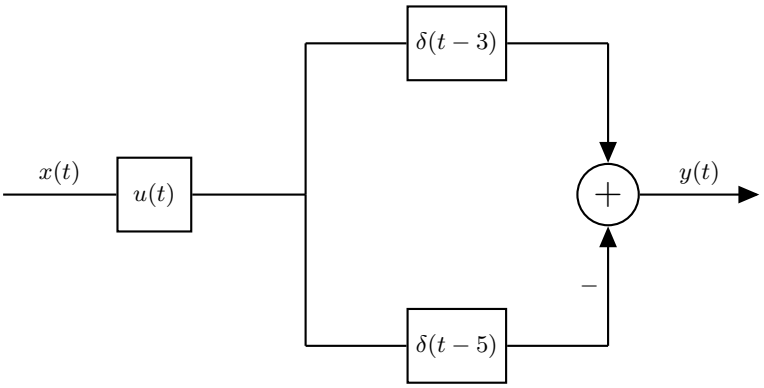
4. (12 pts) Evaluate the following convolutions.
   (a) (6 pts) Given $h(t) = e^{-3t}u(t)$ and $x(t) = e^{-2t}u(t)$, find $y(t) = x(t) * h(t)$.
   (b) (6 pts) Given $h(t) = e^{2t}u(t)$ and $x(t) = u(t) - u(t-2)$, find $y(t) = x(t) * h(t)$.
5. (18 pts) Consider a discrete-time LTI system represented by the unit step response:

$$s[n] = nu[n].$$

   (a) (6 pts) Find the impulse response, $h[n]$, which represents this system.
   (b) (6 pts) Find the input $x[n]$, when the output is $y[n] = \delta[n] - \delta[n-1]$.
   (c) (6 pts) Find the difference equation which represents this system.
6. (10 pts) Consider an LTI system represented by the following unit step response:

$$s(t) = \frac{1}{2}t^2u(t).$$

   For the input $x(t) = e^{-t}u(t)$, find $y(t)$.
7. (15 pts) Consider an LTI system represented by the following block diagram:



   (a) (5 pts) Find and plot the overall impulse response of this system.
   (b) (5 pts) Find the output, $y(t)$, when the input is $x(t) = e^{-3t}u(t)$.
   (c) (5 pts) Find $g(t) = (\frac{dh(t)}{dt}) * x(t)$.