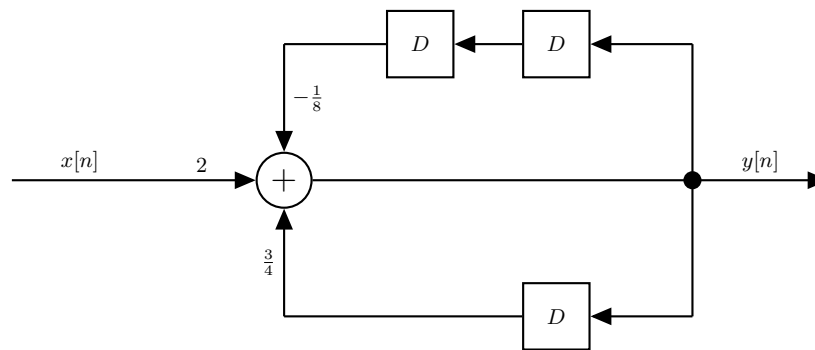




### Regulations:

- **Grouping:** You are allowed to work in pairs.
- **Submission:** We provide a latex template for your solutions. Use that template and create a hw4.tar.gz file that includes hw4.tex and all other related files. Tar.gz file should not contain any directories and should create a hw4.pdf file with the following commands, otherwise you will get zero;  
`tar xvzf hw4.tar.gz`  
`pdflatex hw4.tex`  
 Submit hw4.tar.gz to the COW page of the course.
- **Deadline:** 23:55, 2 June, 2019 (Sunday).
- **Late Submission:** Not allowed.

1. (30 pts) Consider an LTI system given by the following block diagram:



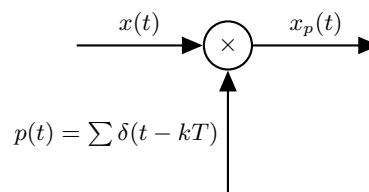
where  $D$  is the unit-delay operator.

- (5 pts) Find the difference equation which represents this system.
  - (5 pts) Find the frequency response of this system.
  - (10 pts) Find the impulse response of this system from its frequency response.
  - (10 pts) Find the output  $y[n]$  for the input  $x[n] = (\frac{1}{4})^n u[n]$  using the frequency response.
2. (10 pts) Suppose that two discrete-time LTI systems with the impulse responses  $h_1[n]$  and  $h_2[n]$  are connected in parallel. We have the following information about this combined system:
- The frequency response of the combined system is;  $H(e^{j\omega}) = \frac{5e^{-j\omega} - 12}{e^{-2j\omega} - 7e^{-j\omega} + 12}$ .
  - The impulse response of the first system is:  $h_1[n] = (\frac{1}{3})^n u[n]$ .

Find  $h_2[n]$ , the impulse response of the second system.

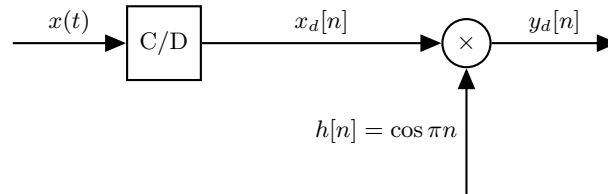
3. (30 pts) Consider the following sampling system where the input is

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



- (10 pts) Find and plot the Fourier Transform of  $x(t)$ .
- (10 pts) What is the Nyquist frequency and period for sampling?
- (10 pts) Find and plot the Fourier Transform of  $x_p(t)$  using the Nyquist rate.

4. (30 pts) Consider the following system with a C/D converter:



where the sampling frequency is  $\omega_s = \pi$  and

$$X(j\omega) = \begin{cases} \frac{4}{\pi}\omega, & \text{if } |\omega| \leq \frac{\pi}{4} \\ 0, & \text{otherwise} \end{cases}$$

- (a) (10 pts) Find  $X_d(e^{j\omega})$ .
- (b) (10 pts) Find  $H(e^{j\omega})$ .
- (c) (10 pts) Find  $Y_d(e^{j\omega})$ .