

This is a open-book exam. Submission due date is **12 pm, noon, April 7th, 2020**. Late submission will not be accepted. If you need more space, please feel free to attach additional papers. Once you're finished, scan and upload it to Canvas course website.

### Honor Pledge

Please review the following honor code, then sign your name and write down the date.

1. I pledge that the answers in this exam are my own and that I will not seek or obtain an unfair advantage in producing these answers. Specifically,
  - (a) I will not plagiarize (copy without citation) from any source;
  - (b) I will not communicate or attempt to communicate with any other person during the exam;
  - (c) neither will I give or attempt to give assistance to another student taking the exam; and
  - (d) I will use only approved devices (e.g., calculators) and/or approved device models.
2. I understand that any act of academic dishonesty can lead to disciplinary action.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

1. (4 points) Derive the Fourier Transform (or Inverse FT) of the given signals.

(a)

$$\mathcal{F} \left\{ \text{sinc}^2(t) \cdot \cos(2\pi f_c t) \right\}, \quad \text{where } f_c \gg 1$$

(b)

$$\mathcal{F}^{-1} \left\{ \frac{1}{2 - f^2 + j3f} \right\}$$

(c)

$$\mathcal{F} \left\{ \text{rect} \left( \frac{t}{\tau} \right) * \text{rect} \left( \frac{t}{\tau} \right) * \text{rect} \left( \frac{t}{\tau} \right) * \text{rect} \left( \frac{t}{\tau} \right) \right\}$$

(d)

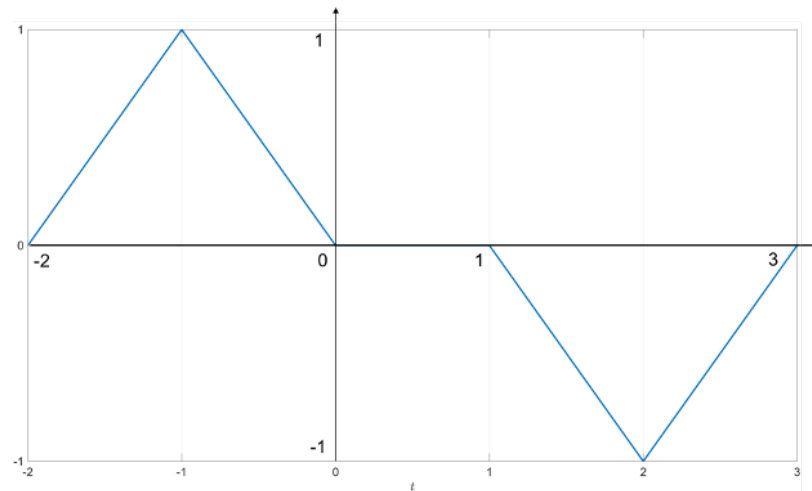
$$\mathcal{F}^{-1} \left\{ \frac{1}{\alpha^2 + j4\pi f\alpha + 4\pi^2(1 - f^2)} \right\}$$

(Answer Page for Question 1)

2. (4 points) Derive the Fourier Transform of the following signals.

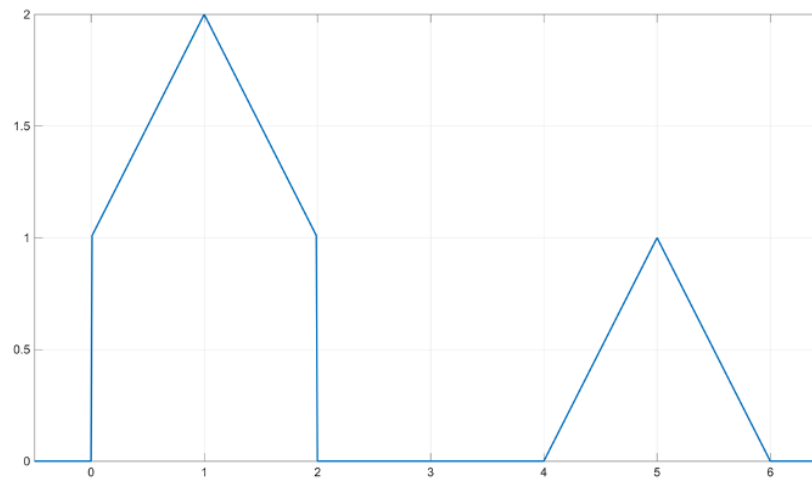
(a)

$$x(t) = \text{tri}(t+1) - \text{tri}(t-2), \quad \text{where } \text{tri}(t) = \begin{cases} 1 - |t|, & |t| < 1 \\ 0, & \text{otherwise} \end{cases}$$



(b)

$$y(t) = y_1(t-1) + \text{tri}(t-5), \quad \text{where } y_1(t) = \text{tri}(t) + \text{rect}\left(\frac{t}{2}\right)$$



(Answer Page for Question 2)

3. (4 points) Consider a continuous LTI system where the input and output are related by the differential equation

$$\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt} + 4x(t)$$

- (a) Find the impulse response  $h(t)$  and frequency response  $H(f)$  of this system

- (b) Find the system output  $y(t)$  for an input signal  $x(t) = e^{-2t}u(t) - 4e^{-3t}u(t)$

(Answer Page for Question 3)

4. (4 points) Consider the following filters with impulse response  $h(t)$ . For each filter, derive the 3-dB bandwidth  $f_{3dB}$  and 70 percent energy containment bandwidth  $f_{70\%}$ , respectively.

a)

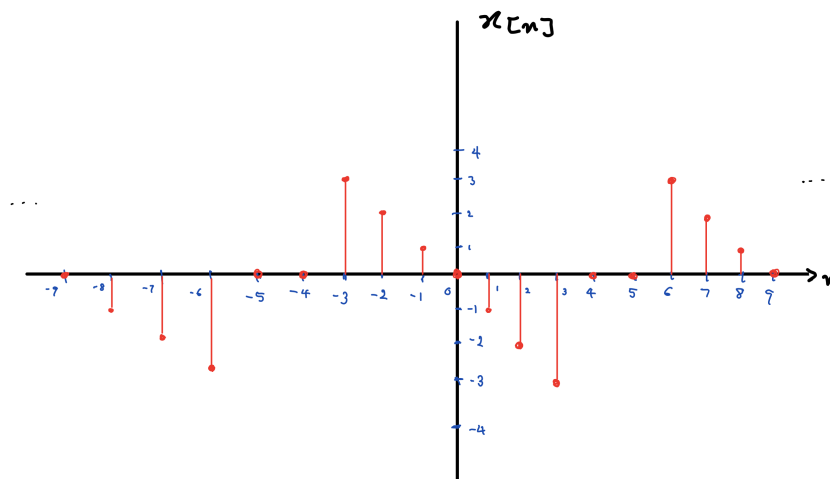
$$h(t) = \frac{\sin(\pi f_0 t)}{f_0 t}, \quad f_0 > 0$$

b)

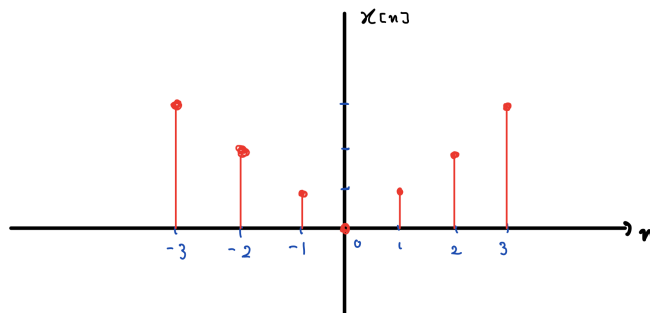
$$h(t) = \frac{1}{t^2 + f_0^2}, \quad f_0 > 0$$

(Answer Page for Question 4)

5. (4 points) (a) Find the discrete-time Fourier series of the sequence  $x[n]$  as plotted below



- (b) Find the discrete-time Fourier transform of the sequence  $x[n]$  as shown below



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(Answer Page for Question 5)