Homework 2
CPE381

Canvas: `hw02`

Due: 18 September 2024, 11:59 PM

You are allowed to use a generative model-based AI tool for your assignment. However, you must submit an accompanied reflection report on how you use the AI tool, what was the query to the tool, and how it improved your understanding of the subject. You must also add your thoughts on how you would tackle the assignment if there was no such tool available. Failure to provide a reflection report for every single assignment where an AI tool was used may result in a penalty and subsequent actions will be taken in line with plagiarism policy.

Submission instruction:

Upload a .pdf on Canvas with the format {firstname.lastname}_cpe381_hw02.pdf. If there is a programming assignment, then you should include your source code along with your PDF files in a zip file firstname.lastname}_cpe381_hw02.zip. Your submission must contain your name, and UAH Charger ID or the UAH email address. Please number your pages as well.

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1 Play with Signals. (10 points)

A continuous-time signal x(t) is shown in Figure 1.

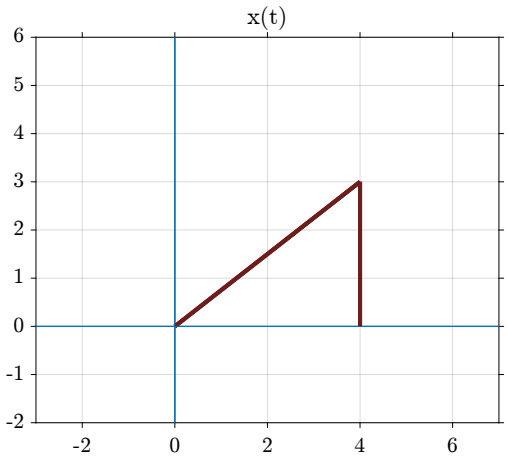

Figure 1: Q1

Sketch and label each of the following signals: (i) $x(t-2)$; (ii) $x(2t)$; (iii) x(t/2); (iv) x(-t); (v) -x(-t).

1.1 Answers:

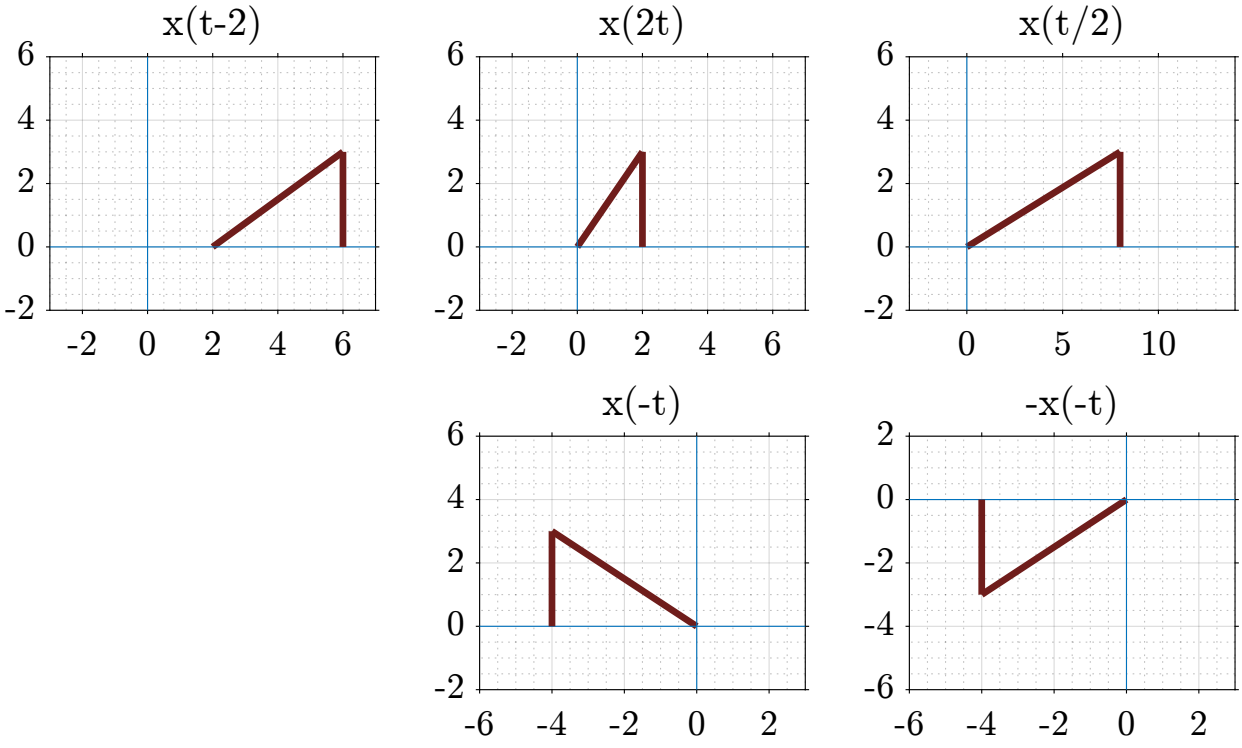

Figure 2: Q1 Answer

2 Picasso of Signals (15 points)

Sketch the following signals:

1. $x(t) = u(t) - u(t-a), \quad a > 0$
2. $y(t) = t[u(t) - u(t-a)]$, $a > 0$
3. $z(t) = u(-t) - u(t)$ where $u(t)$ is the unit-step signal.

2.1 Answers:

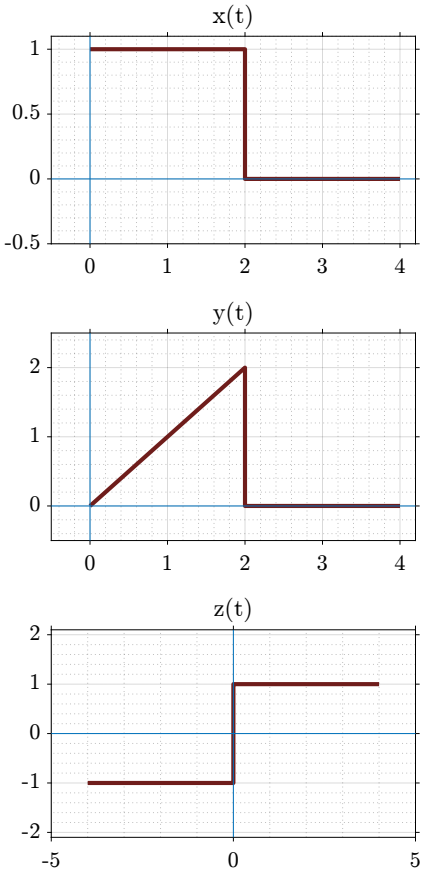

Figure 3: Q2 Answer

3 Divide and Conquer (10 points)

Determine the even and odd components of the following signals:

1. $x(t) = u(t)$.
2. $x(t) = \sin\left(\omega_0 t + \frac{\pi}{4}\right)$

3.1 Answers:

1. $x_e(t) = \frac{1}{2}$, $x_o(t) = \frac{1}{2}\mathbf{sgn}(t)$
2. $x_e(t) = \frac{1}{\sqrt{2}}\cos(\omega_0 t)$, $x_o(t) = \frac{1}{\sqrt{2}}\sin(\omega_0 t)$

4 Rinse and Repeat (15 points)

Determine whether or not each of the following signals is periodic. If signals are periodic, find their fundamental period.

1. $x(t) = \cos\left(2t + \frac{\pi}{4}\right)$.
2. $x(t) = \cos^2(t)$.
3. $x(t) = \cos(2\pi t)u(t)$.

4.1 Answers:

1. Periodic, period = π.
2. Periodic, period = π.
3. Nonperiodic.

5 MATLAB Programming: Signal Plotting (10 points)

Consider

$$y(t) = A\cos(\Omega_c t + s(t))$$

1. $A = 1$, $\Omega_c = 2$, $s(t) = \frac{t^2}{4}$. Use MATLAB to plot the signal for $0 \leq t \leq 40$ seconds in the steps of 0.05. Use sound function to listen to the signal.
2. $A = 1$, $\Omega_c = 2$, $s(t) = -2\sin(t)$. Use MATLAB to plot the signal for $0 \leq t \leq 40$ seconds in the steps of 0.05. Use sound function to listen to the signal.

5.1 Answers:

```
t=0:0.05:40;

y=cos(2*t+t.^2/4);
y1=cos(2*t- 2*sin(t));
fig = figure(14)
subplot(211)
plot(t,y); title('Part 1: linear chirp')
axis([0 20 1.1*min(y) 1.1*max(y)]);grid
subplot(212)
plot(t,y1);title('Part 2: sinusoidal chirp');xlabel('t')
axis([0 20 1.1*min(y1) 1.1*max(y1)]);grid

sound(y);
sound(y1);
```

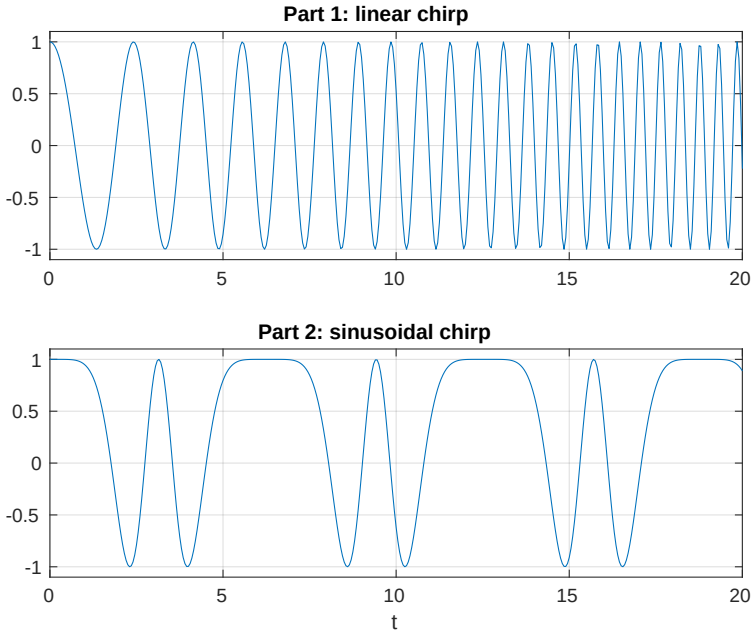

Figure 4: Q5 Answer: HW02, CPE381, FA24

6 Compact Form (20 points)

For Figure 5 below, represent the signal (f) in compact form using transformed version of unit-step function $u(t)$ and ramp signal $r(t)$ as necessary.

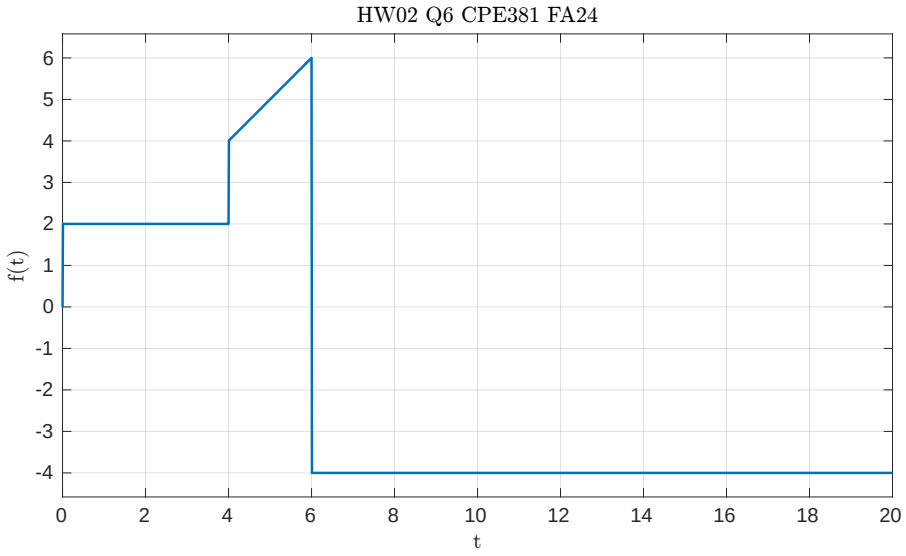

Figure 5: Q6: HW02, CPE381, FA24

Write a MATLAB script to produce Figure 5. Note that the signal for $t < 0$ is zero.

6.1 Answers:

Option 1:

```
% Define the time vector with a step of 0.01
t = 0:0.01:20;

% Initialize the function values
f = zeros(size(t));

% Define the piecewise function
for i = 1:length(t)
    if t(i) > 0 && t(i) <= 4
        f(i) = 2;
    elseif t(i) > 4 && t(i) <= 6
        f(i) = t(i);
    elseif t(i) > 6
        f(i) = -4;
    end
end

% Create the plot
fig = figure;
fig.Position= [421         632        1139         606];
plot(t, f, 'LineWidth', 2);
xlabel('t', 'FontSize', 24, 'Interpreter', 'latex');
ylabel('f(t)', 'FontSize', 24, 'Interpreter', 'latex');
title('HW02 Q6 CPE381 FA24', 'FontSize', 24, 'Interpreter', 'latex');
grid on;
axis equal
set(gca, 'FontSize', 16);
% Save the figure
exportgraphics(fig, '../figures/HW02_Q6_CPE381_FA24.pdf');
```

Option 2:

```
%% Alternatively

% Define the time vector with a step of 0.01
t = 0:0.01:20;

% Define the piecewise function using unit-step (Heaviside) and ramp functions (t)
f = 2 * (heaviside(t) - heaviside(t - 4)) + (t) .* (heaviside(t - 4) - heaviside(t - 6)) - 4 * heaviside(t - 6);

% Create the plot
fig = figure;
fig.Position= [421         632        1139         606];
plot(t, f, 'LineWidth', 2);
xlabel('t', 'FontSize', 24, 'Interpreter', 'latex');
ylabel('f(t)', 'FontSize', 24, 'Interpreter', 'latex');
title('HW02 Q6 CPE381 FA24', 'FontSize', 24, 'Interpreter', 'latex');
grid on;
axis equal;
set(gca, 'FontSize', 16);
```

```
% Save the figure
exportgraphics(fig, '../figures/HW02_Q6_CPE381_FA24.pdf');
```
