INSTRUCTIONS:

- Carry only one side of a $8\frac{1}{2}$" × 11" note and a pencil or a pen with you. The exam is closed-book, closed-note. No calculator is allowed.

- The duration of the exam is 75 minutes.

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Name:
**Problem I** [10 pts]
State whether each of the following statements is TRUE or FALSE.

1. A linear system is time-invariant, but a time-invariant system is not necessarily linear.

2. If $f(t)$ is even, then $-f(t)$ is odd.

3. A periodic signal $f(t)$ is always equal to its Fourier series expansion at every $t$.

4. The sum of two periodic signals is also periodic.

5. The trigonometric Fourier series and the exponential Fourier series of a periodic signal are equivalent.
1. Write the following complex number in polar form:

\[ z = -1 + \sqrt{3}j \]

2. Write the following expression in the form of \( C \cos(\omega_0 t + \theta) \):

\[ f(t) = \cos \omega_0 t - \sin \omega_0 t \]
Problem III  [10 pts]
Consider the signal shown below.

1. Express this signal by a single expression.

2. Plot $f(-t/2 - 1)$. 
Problem IV  [10 pts]
Is the following system linear or nonlinear? Justify your answer.

1. \( y(t) = f(t) + 4 \)

2. \( \frac{dy(t)}{dt} + 5y(t)^2 = 2f(t) \)
Problem V [10 pts]
Is the following system time-invariant or time-varying? Justify your answer.

1. \( y(t) = f(-t) \)

2. \( y(t) = \int_{-1}^{1} f(\tau)d\tau \)
Problem VI  [10 pts]
An LTI system has an impulse response \( h(t) = e^{-2t} u(t - 2) \). Suppose that the input is 
\( f(t) = e^{-t} u(t - 1) \). Calculate the zero-state response.
Problem VII [10 pts]
Calculate the convolution of $f_1(t)$ and $f_2(t)$ using the graphical method, where $f_1(t) = u(t + 2) - u(t)$, $f_2(t) = t[u(t) - u(t - 2)]$. 
Problem VIII  [10 pts] Simply the following expressions.

1. \( \left( \frac{j\omega + 2}{\omega^2 + 9} \right) \delta(\omega) \)

2. \( \int_{-\infty}^{\infty} e^{x-1} \cos \left[ \frac{\pi}{2} (x - 5) \right] \delta(x - 3) \, dx \)
Problem IX  [10 pts]

\[ f(t) \text{ is periodic with period } T_0 = 2, \text{ and } f(t) = u(t + 1/2) + u(t - 1/2) \text{ for } -1 \leq t \leq 1. \]

1. Find its trigonometric Fourier series.

2. Find its exponential Fourier series.
Problem X  [10 pts]
The trigonometric Fourier series of a periodic signal is given by

\[ f(t) = 1 + 2 \cos\left( t - \frac{\pi}{2} \right) + 2\sqrt{2} \sin\left( 3t - \frac{\pi}{4} \right). \]

1. What is the fundamental period of this signal?

2. Sketch the trigonometric Fourier spectra.

3. Sketch the exponential Fourier spectra.