**GEORGIA INSTITUTE OF TECHNOLOGY**

SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

# QUIZ #4

DATE: 23-April-10 COURSE: ECE-2025

NAME: ______________________________ GT username: ______________

LAST, FIRST (ex: gpburdell8)

3 points 3 points 3 points

Recitation Section: Circle the date & time when your **Recitation Section** meets (not Lab):

| | | |
|---|---|---|
| | L05:Tues-Noon (Michaels) | L06:Thur-Noon (Bhatti) |
| | L07:Tues-1:30pm (Michaels) | L08:Thur-1:30pm (Bhatti) |
| L01:M-3pm (Lee) | L09:Tues-3pm (Fekri) | |
| L03:M-4:30pm (Lee) | L11:Tues-4:30pm (Fekri) | |

- Write your name on the front page ONLY. **DO NOT** unstaple the test.
- Closed book, but a calculator is permitted.
- One page ($8\frac{1}{2}'' \times 11''$) of **HAND-WRITTEN** notes permitted. OK to write on both sides.
- **JUSTIFY** your reasoning CLEARLY to receive partial credit.
  Explanations are also required to receive **FULL** credit for any answer.
- You must write your answer in the space provided on the exam paper itself.
  Only these answers will be graded. Circle your answers, or write them in the boxes provided.
  If space is needed for scratch work, use the backs of previous pages.

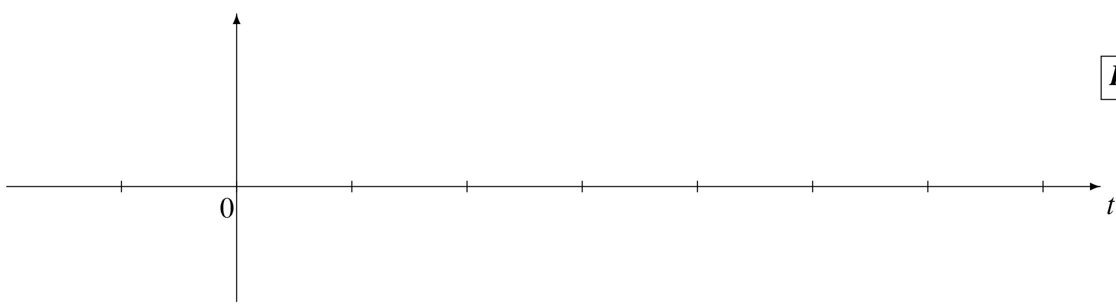
| *Problem* | *Value* | *Score* |
|---|---|---|
| 1 | 30 | |
| 2 | 30 | |
| 3 | 20 | |
| 4 | 20 | |
| No/Wrong Rec | −3 | |

**PROBLEM Spring-10-Q.4.1:**

In each of the following cases, use properties of the unit-impulse signal $\delta(t)$ to simplify the expression ***as much as possible.*** Provide some **explanation** or intermediate steps for each answer. *Note:* Star $*$ is the convolution operator.

(a) Simplify $x(t) = \dfrac{\sin(7\pi(t-5))}{22(t-5)}\,\delta(t-5)$.

(b) Simplify $y(t) = \displaystyle\int_{-10}^{30} 50\,\delta(\lambda - t)\,d\lambda$. Give your answer as a plot vs. $t$.




***Label all points***

(c) Simplify $z(t) = \left(\dfrac{d}{dt}\left\{200\sin(\tfrac{1}{2}\pi t)\,u(t-3)\right\}\right) * \delta(t-25)$

**PROBLEM Spring-10-Q.4.2:**

In each of the following cases, determine the (inverse or forward) Fourier transform. Give your answer as a plot, or a simple formula. ***Explain*** each answer (briefly) by stating which property and/or transform pair was used.

(a) Find $a(t)$ when $A(j\omega) = \left[\omega^2 + j7\omega + \frac{1}{2}\right]\delta(\omega)$. Simplify to get a real-valued answer.

(b) Find $b(t)$ when $B(j\omega) = \dfrac{10}{100 + j5\omega}$.

(c) Find $C(j\omega)$ when $c(t) = \sqrt{\pi}\,u(t-30) - \sqrt{\pi}\,u(t-40)$.

**PROBLEM Spring-10-Q.4.3:**

Two questions about convolution (denoted by the $*$ operator):

(a) In the following convolution the result $y(t)$ is a single sinusoid, $y(t) = A\cos(\omega t + \varphi)$. Determine $A$, $\varphi$ and $\omega$.

$A =$

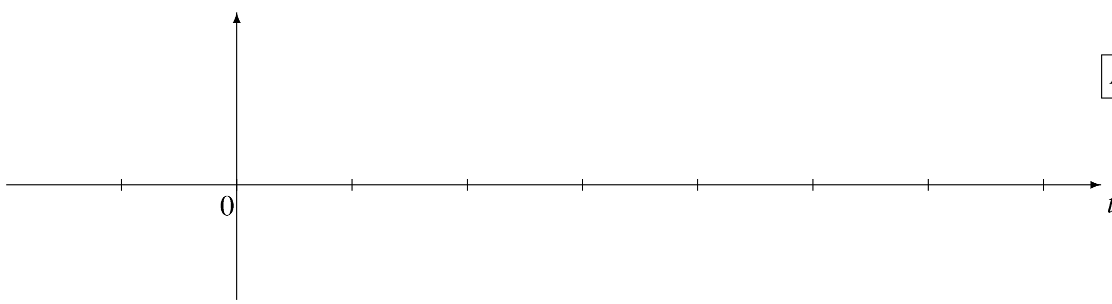
$\varphi =$

$\omega =$

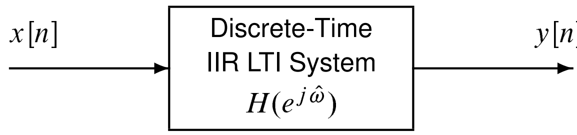
$$y(t) = \frac{0.7\sin(600\pi(t-0.001))}{\pi(t-0.001)} * [\cos(500\pi t) + \cos(1000\pi t)]$$

(b) Find the output of a LTI system whose impulse response is $h(t) = 0.5[u(t) - u(t-100)]$ when the input is a rectangular pulse signal, $x(t) = 0.2[u(t-300) - u(t-400)]$. Give the answer as a **plot**. Label the vertical height, as well as the horizontal axis.

***Label all points***



**PROBLEM Spring-10-Q.4.4:**




(a) Lab #11 dealt with the design of two-pole IIR bandpass filters. The frequency axis for $H(e^{j\hat{\omega}})$ is $-\pi < \hat{\omega} \leq \pi$. Suppose that the relationship between the 3-dB passband width and the pole radius is

$$\Delta\hat{\omega} = 2(1-r)$$

where $\Delta\hat{\omega}$ is the 3-dB passband width and $r$ is the radius of the pole pair used to create the passband. Determine the poles and zeros of a second-order IIR filter whose frequency response meets the following specs: zero at $\hat{\omega} = \pi$ and at DC; passband over the region $0.7\pi \leq \hat{\omega} \leq 0.74\pi$.

POLES: $z =$

ZEROS: $z =$

(b) The system function of an IIR notch filter has the form:

$$H(z) = \frac{(1-e^{j2.1}z^{-1})(1-e^{-j2.1}z^{-1})}{(1-0.7e^{j2.1}z^{-1})(1-0.7e^{-j2.1}z^{-1})}$$

Write the appropriate MATLAB code to use the system defined by this $H(z)$ to filter a discrete-time signal $x[n]$ to get the output $y[n]$. Assume that the input signal $x[n]$ is contained in the MATLAB vector `xn`, and call the output vector `yn`. Numerical values will needed in all vectors that are used to set up the filtering in MATLAB. You can either give these numerical values explicitly, or write MATLAB statements that would generate them.

```
yn =
```