GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

QUIZ #3

DATE: 21-Nov-03 COURSE: ECE 2025

NAME: ______________________________ GT LOGIN: ______________

LAST, FIRST

Recitation Section: **Circle the day & time** when your Recitation Section meets:

L01:Tues-9:30 (G. Li)	L02:Thur-9:30 (G-K. Chang)
L03:Tues-12:00 (G. Li)	L04:Thur-12:00 (G-K. Chang)
L05:Tues-1:30 (M. Richards)	L06:Thur-1:30 (T. Zhou)
L07:Tues-3:00 (M. Richards)	L08:Thur-3:00 (T. Zhou)
L09:Tues-4:30 (Y. Altunbasak)	L10:Thur-4:30 (G. Casinovi)
L11:Tues-6:00 (Y. Altunbasak)	L13:Mon-3:00 (J. McClellan)
L14:Wed-3:00 (R. Butera)	L16:Wed-4:30 (R. Butera)
Savannah (G. AlRegib)	

- Write your name on the front page ONLY. **DO NOT** unstaple the test.
- Closed book, but a calculator is permitted. However, one page ($8\frac{1}{2}'' \times 11''$) of HAND-WRITTEN notes permitted. OK to write on both sides.
- Unless stated otherwise, justify your reasoning clearly to receive any 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	20	
2	20	
3	20	
4	20	
5	20	

Problem Q3.1:

Use the properties of the continuous-time delta function to simplify the following expressions:

(a) $t^4\delta(t-2) =$

(b) $\frac{d}{dt}\{t^4 u(t-2)\} =$

(c) $\int_{-\infty}^{\infty} t^4\delta(t-2)dt =$

(be sure to explain your reasoning)

Problem Q3.2:

Suppose an LTI filter has a system function given by

$$H(z) = \frac{1 + z^{-1} + z^{-2}}{1 + 0.5z^{-1}}$$

(a) Plot the poles and zeros of $H(z)$.

(b) What frequencies $\hat{\omega}$ between $-\pi$ and π of any input signal will be completely nulled out by the filter?

(c) Find the difference equation describing the input/output relationship of the system in terms of an input $x[n]$ and an output $y[n]$.

(d) Suppose that a signal $x[n]$ with z-transform given by

$$X(z) = \frac{z^{-2}}{1 + z^{-1} + z^{-2}}$$

is input to the system. Find the output signal $y[n]$.

Problem Q3.3:

Suppose $h(t) = t^3[u(t) - u(t-6)]$ and $x(t) = \tan(t)[u(t-1) - u(t-3)]$. Fill in the boxes in the following first step of computing the convolution of $h(t)$ with $x(t)$, where we are choosing to let $h(t)$ be the function that we are flipping and shifting:

$$(h * x)(t) = \begin{cases} 0 & \text{for } t \leq \boxed{} \\ \int_{\boxed{}}^{\boxed{}} (t-\tau)^3 \tan(\tau) d\tau & \text{for } \boxed{} < t \leq \boxed{} \\ \int_{\boxed{}}^{\boxed{}} (t-\tau)^3 \tan(\tau) d\tau & \text{for } \boxed{} < t \leq \boxed{} \\ \int_{\boxed{}}^{\boxed{}} (t-\tau)^3 \tan(\tau) d\tau & \text{for } \boxed{} < t \leq \boxed{} \\ 0 & \text{for } t > \boxed{} \end{cases}$$

Just fill in the boxes. Don't try to work any more of the convolution, i.e. don't try actually working out the integrals! (Notice we picked t^3 and $\tan(t)$ rather arbitrarily. The point of the problem is to see if you can figure out the limits of the integrals and what the different regions are.)

Problem Q3.4:

Suppose a continuous-time LTI system has an impulse response given by $h(t) = 100\pi \exp(-20\pi t)u(t)$.

(a) Find an expression for the output $y(t)$ if the input is $x(t) = \delta(t - 2)$. Draw a labeled sketch of $y(t)$. (Your sketch need not be a work of art; just put in enough details so the grader can be sure you know understand what $y(t)$ looks like.)

(b) Find the output $y(t)$ if the input is $x(t) = \sqrt{2}\cos(20\pi t)$. (Express your answer as simply as possible; for instance, we don't want to see a convolution operator in the final answer.)

Problem Q3.5:

Consider a system whose impulse response is given by

$$h(t) = \frac{\sin(5000\pi t)}{\pi t}$$

Suppose the system is given an input $x(t)$ specified by the Fourier series

$$\sum_{k=-\infty}^{\infty} \frac{1}{|k|^2 + 2} e^{jk3000\pi t}$$

(a) Find $H(j\omega)$, the Fourier transform of $h(t)$. Give your answer as either a formula or a carefully labeled sketch, whichever you find most convenient.

(b) Find the output $y(t)$. (Be sure to write your answer entirely using "real" quantities, i.e., don't leave any complex exponentials in your answer.)