

Department of Electrical, Computer, and Software Engineering
Faculty of Engineering and Applied Science
University of Ontario Institute of Technology

ELEE 3110U: Signals and Systems

Final Exam

Fall 2021

First Name:

Last Name:

Student Number:

Important Points:

- Do not forget to enter your personal information.
- Use of a non-programmable calculator is allowed.
- The exam is open book and open note.
- Your answers must be the logical results of your derivations and analysis. Answers without proper clear justifications may not receive any marks.
- The exam is out of 110. If you secure any mark between 100 and 110 points, you will receive full mark. If you secure a mark of X out of 110, you have secured $X\%$ of the full mark of the final exam.
- **Good Luck**

- **Problem 1 (10 points):** The input to an LTI system with impulse response $h(t) = e^{2j\omega_0 t}$ is given by

$$x(t) = \begin{cases} 1, & -4 \leq t \leq 4 \\ 0, & \text{otherwise.} \end{cases} \quad (1)$$

Find all values of ω_0 for which the output $y(t)$ is zero for $t = 0$.

- **Problem 2 (20 points):** Let $x(t)$ and $y(t)$ be the input and the output of an LTI system whose impulse response is $h(t)$.

- What is the output of this system to the input given by $\frac{dx(t)}{dt}$. Show how you arrive at your answer.
- What is the output of this system to the input given by $\int_{-\infty}^t x(\tau)d\tau$. Show how you arrive at your answer.
- What is the output of the system with impulse response $\int_{-\infty}^t h(\tau)d\tau$ to the input given by $\int_{-\infty}^t x(\tau)d\tau$. Show how you arrive at your answer.
- What is the output of the system with impulse response $\frac{dh(t)}{dt}$ to the input given by $\int_{-\infty}^t x(\tau)d\tau$. Show how you arrive at your answer.

- **Problem 3 (30 points):** An LTI system has impulse response given by

$$h(t) = e^{-2|t|} + e^{-3|t|} \quad (2)$$

Obtain the output of this system to the following inputs

- $x(t) = \sum_{n=-\infty}^{+\infty} \delta(t - 2n)$
- $x(t) = \sum_{n=-\infty}^{+\infty} (-1)^n \delta(t - 4n)$
- $x(t)$ is a periodic signal with period 4 and is described in one period as

$$x(t) = u(t + 1) - u(t - 1), \text{ for } -2 \leq t \leq 2. \quad (3)$$

- **Problem 4 (30 points):** An LTI system has the following impulse response

$$h(t) = \frac{\sin(8(t - 2))}{\pi(t - 2)} \quad (4)$$

Obtain the output of this system to the following inputs

- $x(t) = \sin(4t + \frac{\pi}{3})$
- $x(t) = \sum_{k=-\infty}^{\infty} 3^{-|k|} \cos(4kt)$
- $x(t) = \frac{\sin(6(t + 1))}{\pi(t + 1)}$
- $x(t) = \left(\frac{\sin 4t}{\pi t} \right)^2$

- **Problem 5 (20 points):** An LTI system has four poles at $-3, -1 \pm j, +2$ and two zeros at 1 and 3.
 - a) Indicate all possible ROCs that can be associated with this zero-pole pattern. Justify your answer properly.
 - b) For each possible ROC that you identified in part (a), specify whether the associated system is stable and/or causal.