University of Victoria
Exam 1
Fall 2023

Course Name:	**ECE 260**
Course Title:	**Continuous-Time Signals and Systems**
Section(s):	**A01, A02**
CRN(s):	**A01 (CRN 11010), A02 (CRN 11011)**
Instructor:	**Michael Adams**
Duration:	**50 minutes**

Family Name: _____

Given Name(s): _____

Student Number: _____

This examination paper has **8 pages**, all of which are numbered.

Students must count the number of pages in this examination paper before beginning to write, and report any discrepancy immediately to the invigilator.

All questions are **to be answered on the examination paper** in the space provided.

Total Marks: 24

This examination is **closed book**.

The use of a crib sheet is **not** permitted.

The use of a calculator is **not** permitted.

You must **show all of your work!**

You must **clearly define any new quantities** introduced in your answers (such as variables, functions, operators, and so on).

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Do not write on this page unless instructed to do so.

Question 1.

Consider the function f given by $f(z) = \dfrac{z^2 + 2z + 1}{(z^4 - 9z^2)^3}$, where z is complex. Find the (finite) poles and zeros of f as well as their corresponding orders. **Show all of your work** and **do not skip any steps** in your answer. **[4 marks]**

Question 2. Find a **fully simplified** formula for $x(t)$, where

$$x(t) = \int_t^\infty \tau \delta(-3\tau - 1)d\tau + \int_{-6}^6 \tau \cos(\tau)\delta(\tau + 10)d\tau.$$

Show all of your work and **do not skip any steps** in your solution. You must express your final answer **in terms of the unit-step function** to whatever extent is possible. Your solution is **not permitted** to use the time scaling property of δ. **[5 marks]**

Question 3. Consider the (single-input single-output) system associated with the operator $\mathscr{H}$.

(A) State, in mathematical terms, the condition that must be satisfied for $\mathscr{H}$ to be linear. You must use **operator notation** (e.g., do not use arrow notation). You must **fully define all variables** (e.g., functions and constants) appearing in your answer and be specific about **what values they can take**. Be very careful about the use of words like "all" or "every" or "one", as such words are often of **critical importance**. Failing to heed the above guidance will likely result in a **mark of zero** on this question. **[2 marks]**

(B) Suppose now that $\mathscr{H}x(t) = 3x(t) - 1$. **Using the condition stated in your answer to part (a)** of this question, determine whether $\mathscr{H}$ is linear. (Not using the condition as stated in your answer to part (a) will likely result in a **mark of zero**.) **[2 marks]**

Question 4.

Consider the functions x and y, where $x(t) = \operatorname{rect}(t)$ and y is as shown in the figure. Find y in terms of x. The expression for y should have a minimal number of terms. **Show all of your work** and **do not skip any steps** in your answer. **[4 marks]**
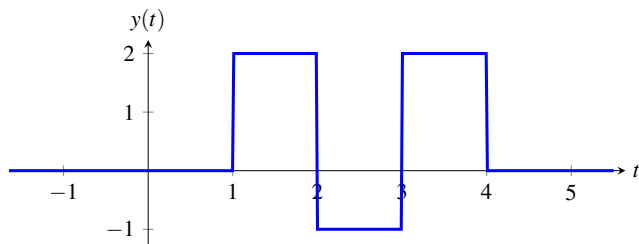
Question 5. A system $\mathscr{H}$ is characterized by the equation $\mathscr{H}x(t) = ax^2(t) + b$, where a and b are real constants. The functions $x_1(t) = 1$ and $x_2(t) = -2$ are eigenfunctions of $\mathscr{H}$ with the eigenvalues $\lambda_1 = -3$ and $\lambda_2 = 3$, respectively. Find a and b. **Show all of your work** and **do not skip any steps** in your answer. **[4 marks]**

Question 6. Using the MATLAB programming language, write a function called `foo` that takes an $m \times n$ real-valued matrix A and returns an $m \times n$ real-valued matrix B, where $b = B_{k,\ell}$ (i.e., the (k,ℓ)th element of B) is computed from $a = A_{k,\ell}$ (i.e., the (k,ℓ)th element of A) as follows:

$$b = \begin{cases} 0 & a < 1 \\ (a-1)^2 & 1 \le a < 3 \\ 4 & \text{otherwise.} \end{cases}$$

For example, the function calls `foo([0 1; 2 3 ; 4 5])` and `foo([1 2 3])` should return `[0 0; 1 4; 4 4]` and `[0 1 4]`, respectively. The **only functions** that your code is permitted (but not required) to call are `width` and `height`. (Recall that, for a matrix x, `height(x)` and `width(x)` yield the number of rows and columns in x, respectively.) Your code must **use proper indentation** and **must not exceed 18 lines** in length. Be sure to **use correct syntax** in your answer, since syntax clearly matters here. **[3 marks]**

Line #	Line of Code
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