University of Victoria
Exam 1
Fall 2024

Course Name:	**ECE260**
Course Title:	**Continuous-Time Signals and Systems**
Section(s):	**A01, A02**
CRN(s):	**A01 (CRN 10960), A02 (CRN 10961)**
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: 25

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.

A function x (of a real variable) has the following properties:

1. the function v is causal, where $v(t) = x(t-3)+1$;
2. the function w is even, where $w(t) = x(t-2)+1$; and
3. $x(t) = -(t+2)^2$ for $-3 \leq t \leq -2$.

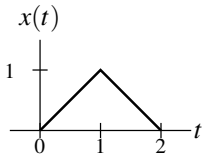
Find x (i.e., find $x(t)$ for all t) if such a function exists. If no such function exists, formally show that this is the case. You must **clearly explain** how you arrived at your answer. **Show all of your work** and **do not skip any steps** in your answer. A correct final answer for x will receive zero marks if it is not fully justified (with a clear explanation of every step), since the **justification** of each of the steps leading to the final answer is **absolutely essential**. **[5 marks]**

Question 2. Consider the complex-valued function H of a real variable, given by $H(\omega) = \dfrac{-5}{(-1-j\omega)^4}$.

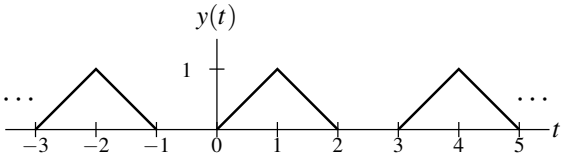
(A) Find a fully simplified expression for $|H(\omega)|$. **[2 marks]**

(B) Find a fully simplified expression for $\arg H(\omega)$. **[2 marks]**

Question 3.



(A) Consider the function x shown in the figure to the right. Use unit-step functions to find a single expression for $x(t)$ that is valid for all t. When stating your final answer, you must **group together terms having the same unit-step function factor. [3 marks]**



(B) Consider the periodic function y with fundamental period $T = 3$ shown in the figure to the right. **Use the result of part (a)** to find a single expression for $y(t)$ that is valid for all t. To save writing, you may state your final answer in terms of x, where the formula that would be substituted for x is assumed to be the one determined in part (a). **[1 mark]**

Question 4. 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**. Since definitions require precise wording, this question must be answered using **complete sentences**, not point form. 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 $\mathscr{H}x(t) = 2x(t) + 3$. **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 5. Write a MATLAB function called `func` that takes an $m \times n$ (real) matrix t and returns a matrix x of the same dimensions where $x_{i,j} = f(t_{i,j})$ and

$$f(t) = \begin{cases} \dfrac{(t+1)^9(t+2)^7}{t+3} & 0 \leq t < 3 \\ \dfrac{\sin(\pi t)}{t+1} & 3 \leq t < 6 \\ 0 & \text{otherwise.} \end{cases}$$

Note that $x_{i,j}$ and $t_{i,j}$ denote the (i,j)th element of x and t, respectively. Your code is **not permitted** to use any conditional statements (such as **`if`** statements) or looping constructs (such as **`for`** or **`while`** statements). Recall that, in MATLAB, an ellipsis (i.e., "`...`") **must be used** to continue a statement onto the next line. Your code must **use proper indentation** and **must not be excessively long**. Be sure to **use correct syntax** in your answer, since syntax clearly matters here. **[3 marks]**

Line #	Line of Code
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Question 6. A system $\mathscr{H}$ is characterized by the equation $\mathscr{H}x(t) = Ax^3(t) + B$, where A and B are real constants. The function $x_1(t) = -1$ is an eigenfunction of $\mathscr{H}$ with eigenvalue $\lambda_1 = -9$, and the function $x_2(t) = 2$ is an eigenfunction of $\mathscr{H}$ with eigenvalue $\lambda_2 = 9$. Find A and B. **[5 marks]**

END