EE301 Midterm #1

1. Enter your name, student ID number, e-mail address and your full signature in the space provided on this page.

2. You have **fifty minutes**.

3. There are **10** pages in the exam booklet. Use the back of each page for rough work, if necessary.

4. You are **not** allowed the use of crib sheets.

5. You are **not** allowed the use of calculators.

6. Tip: Make sure you read through the exam once before beginning. Work as quickly and efficiently as you can. If you get stuck on a certain problem, move on to others.

7. **Unless otherwise instructed, no justification is necessary.**

8. **Unless otherwise stated, no partial credit will be given, therefore work as carefully as you can.**

9. **Enter your answers in the spaces provided.**

<table>
<thead>
<tr>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student ID #:</td>
</tr>
<tr>
<td>E-mail address:</td>
</tr>
<tr>
<td>Signature:</td>
</tr>
</tbody>
</table>
1. (30 pts)

A continuous-time signal $x(t)$ is defined by

$$x(t) = \begin{cases} 
0, & -\infty < t \leq -1, \\
1, & -1 < t \leq 1, \\
-1, & 1 < t \leq 2, \\
0, & 2 < t < \infty.
\end{cases}$$

A sketch of $x(t)$ is shown below.

- A number of questions based on this signal are given on the next page. Answer them, making sure to enter your answers in the spaces provided on the next page. **Failure to do so may result in your getting zero credit.** Use the space below and the back of this page for any rough work.

- No partial credit will be given for any part of this problem, therefore work as carefully as you can.

- No justification is necessary.
(a) (3 pts) Calculate $E_\infty$ for $x(t)$, i.e., the energy of $x(t)$ over the interval $(-\infty, \infty)$.

$$E_\infty =$$

(b) (3 pts) Calculate $P_\infty$ for $x(t)$, i.e., the power of $x(t)$ over the interval $(-\infty, \infty)$.

$$P_\infty =$$

(c) (2 pts) Sketch $x(t - 1)$ below.

(d) (2 pts) Sketch $x(t + 1)$ below.

(e) (5 pts) Sketch $x(0.5t)$ below.

(f) (5 pts) Sketch $x(1 - 0.5t)$ below.

(g) (5 pts) Sketch the even part of $x(t)$ below.

(h) (5 pts) Sketch the odd part of $x(t)$ below.
2. (20 pts) Classify the following signals as periodic or Non-periodic; for periodic signals, calculate the fundamental period. Enter your answers in the spaces provided.

- No partial credit will be given for any part of this problem, therefore work as carefully as you can.
- No justification is necessary.

(a) (4 pts) \( x(t) = \sin(4t + \pi/8) \).

\[ \begin{array}{ll}
\square & \text{Non-periodic} \\
\square & \text{Periodic; Period = } \\
\end{array} \]

(b) (4 pts) \( x(t) = \sin t + \sin(2t + \pi/8) \).

\[ \begin{array}{ll}
\square & \text{Non-periodic} \\
\square & \text{Periodic; Period = } \\
\end{array} \]

(c) (4 pts) \( x[n] = e^{j\pi n/8} \).

\[ \begin{array}{ll}
\square & \text{Non-periodic} \\
\square & \text{Periodic; Period = } \\
\end{array} \]

(d) (4 pts) \( x[n] = 2^{-n} e^{j\pi n/8} \).

\[ \begin{array}{ll}
\square & \text{Non-periodic} \\
\square & \text{Periodic; Period = } \\
\end{array} \]

(e) (4 pts) \( x[n] = e^{jn/8} \).

\[ \begin{array}{ll}
\square & \text{Non-periodic} \\
\square & \text{Periodic; Period = } \\
\end{array} \]
3. (10 pts) Determine if the following systems (with input \( x \) and output \( y \)) are linear or nonlinear; time-invariant or time-varying; memoryless or with-memory; causal or non-causal; stable or unstable.

- No partial credit will be given for any part of this problem, therefore work as carefully as you can.
- No justification is necessary.

(a) (5 points) \( y(t) = \frac{d}{dt}(x(t)). \)

\[
\begin{array}{ll}
\square \text{Linear} & \square \text{Nonlinear} \\
\square \text{Time-invariant} & \square \text{Time-varying} \\
\square \text{Memoryless} & \square \text{With-memory} \\
\square \text{Causal} & \square \text{Noncausal} \\
\square \text{Stable} & \square \text{Unstable}
\end{array}
\]

(b) (5 points) \( y[n] = \begin{cases} 0 & n < 0, \\ \sum_{0}^{n} x(n) & n \geq 0. \end{cases} \)

\[
\begin{array}{ll}
\square \text{Linear} & \square \text{Nonlinear} \\
\square \text{Time-invariant} & \square \text{Time-varying} \\
\square \text{Memoryless} & \square \text{With-memory} \\
\square \text{Causal} & \square \text{Noncausal} \\
\square \text{Stable} & \square \text{Unstable}
\end{array}
\]
4. (20 points) Let the impulse response $h(t)$ of a continuous-time LTI system be

$$h(t) = \begin{cases} 
0 & t < 0, \\
1 & t \geq 0.
\end{cases}$$

Thus, the impulse response is simply the unit step function.

For this system, suppose the input signal is

$$x(t) = \begin{cases} 
0 & -\infty < t \leq 0, \\
t & 0 < t \leq 1, \\
1 & 1 < t \leq \infty.
\end{cases}$$

A sketch of $x(t)$ is shown below:

Find the output $y(t)$, and sketch it on the graph provided on the next page.

- You must show all the work you did in determining $y(t)$. Merely writing down your answer with no justification will likely earn you zero credit.
- Work as neatly as you can.
- Use the back of this page, if you need extra space.
Sketch the output $y(t)$ of the system here.
5. (20 points)

For all parts of this problem:

- **You must show all the work you did in obtaining your answers.** Merely writing down your answers with no justification will likely earn you zero credit.
- Work as neatly as you can.

The output $y(t)$ of a causal LTI system corresponding to the input

$$x(t) = \begin{cases} 
0 & -\infty < t \leq 0, \\
1 & 0 < t \leq 1, \\
0 & 1 < t < \infty.
\end{cases}$$

is

$$y(t) = \begin{cases} 
0 & -\infty < t \leq 0.5, \\
2(t - 0.5) & 0.5 < t \leq 1.5, \\
2 & 1.5 < t < \infty.
\end{cases}$$

A sketch of the input $x(t)$ and the output $y(t)$ are shown below:

(a) (5 pts) Find the output of the system corresponding to the input $x(0.5t)$, and sketch it on the graph provided on the next page.
Sketch the output of the system corresponding to the input $x(0.5t)$ here.
(b) (15 pts) Find the impulse response of the system, and sketch it on the graph below.