MTH 352/652
Computational Assignment #1

First Due Date: March 07, 2025

Ground Rules:

1. You will submit your assignments via e-mail. Each individual problem should be a Mathematica Notebook. Format the assignments by naming your notebooks LastnameProblem-number.nb. For example, for the second problem I would save my Mathematica Notebook as Gemmer2.nb.
2. You cannot use ChatGPT or copy code from the internet or your classmates. However, you are more than welcome to work with your classmates and you can use the internet to get ideas of how to write code. For example, searching for something like "how to define a piecewise function in Mathematica" is totally fine. Searching for something like "Give me code for solving the heat equation with a step function" is not good.
3. You can hand in the assignment as many times as you would like as long as you hand in your assignment weekly by Friday at 11:00 AM. If you miss any week you will earn the grade of the last submitted assignment. This is to prevent students from putting off the assignment until the end of the semester.

1 Problem #1

Modify the "Heat Equation on the Line" Mathematica Notebook on the course website to solve the heat equation

$$u_t = u_{xx}$$

$$u(x,0) = \begin{cases} 1 & |x| < 1 \\ 0 & |x| \geq 0 \end{cases}.$$

Your code should:

1. At times $t = 0, 5, 10$, plot the solution on the interval $[-10, 10]$.
2. Plot a density or contour plot on the domain $x \in [-10, 10]$, $t \in [0, 10]$.
3. Use the animate command to plot a movie of the evolution of the solution on the spatial domain $[-10, 10]$ for times t ranging from 0 to 10.

Hint: You can use The Mathematica Notebook "Wave Equation on the Line" to obtain an example of how to define a piecewise defined function.

2 Problem #2

Modify the "Heat Equation on the Line" Mathematica Notebook on the course website to solve the heat equation

$$u_t + u_x = u_{xx}$$
$$u(x,0) = \begin{cases} 1 & |x| < 1 \\ 0 & |x| \geq 0 \end{cases}.$$

Your code should:

1. At times $t = 0, 5, 10$, plot the solution on the interval $[-10, 10]$.
2. Plot a density or contour plot on the domain $x \in [-10, 10]$, $t \in [0, 10]$.
3. Use the animate command to plot a movie of the evolution of the solution on the spatial domain $[-10, 10]$ for times t ranging from 0 to 10.

3 Problem #3

Modify the "Wave Equation on the Line" Mathematica Notebook on the course website to solve the wave equation

$$u_{tt} = u_{xx}$$
$$u(x,0) = \begin{cases} 1 & |x| < 1 \\ 0 & |x| \geq 0 \end{cases}$$
$$u_t(x,0) = 0.$$

Your code should:

1. At times $t = 0, 5, 10$, plot the solution on the interval $[-10, 10]$.
2. Plot a density or contour plot on the domain $x \in [-10, 10]$, $t \in [0, 10]$.
3. Use the animate command to plot a movie of the evolution of the solution on the spatial domain $[-10, 10]$ for times t ranging from 0 to 10.

4 Problem #4

Modify the "Wave Equation on the Line" Mathematica Notebook on the course website to solve the wave equation

$$u_{tt} = u_{xx}$$
$$u(x,0) = 0$$
$$u_t(x,0) = \begin{cases} 1 & |x| < 1 \\ 0 & |x| \geq 0 \end{cases}.$$

Your code should:

1. At times $t = 0, 5, 10$, plot the solution on the interval $[-10, 10]$.
2. Plot a density or contour plot on the domain $x \in [-10, 10]$, $t \in [0, 10]$.
3. Use the animate command to plot a movie of the evolution of the solution on the spatial domain $[-10, 10]$ for times t ranging from 0 to 10.