Final Project

Due Tuesday, May 21 at 5:00.

Write a C++ program that simulates the diffusion of heat in one dimension.

As input, the program should take
- The type of boundary data (Dirichlet or Neumann) at each endpoint and its value.
- The diffusion coefficient.
- The user should be able to use the mouse to determine the initial data.
- The step size for the simulation.
- The total time for the simulation.

As output, the program should return
- A graphical representation of temperature of the object.

Program features
- The user should be able to select which method is used to compute the solution—either Forward-Time Central-Space, or Backward-Time Central-Space.

The program should be written using good object oriented programming techniques.

You are then to answer the following questions:

1. Consider a 60 cm long steel rod (with \( \gamma = 0.15 \, \text{cm}^2/\text{s} \)). Suppose that the ends are kept at \( 0^\circ \), and that initially the first 30 cm of the rod are at \( 100^\circ \), while the last 30 cm of the rod are at \( 0^\circ \). Use your simulation to determine the temperature of the rod after 10 minutes have elapsed. What is the value of the temperature at the center of the rod?

2. Consider the same steel rod. Suppose that heat is supplied through the left end of the rod at the rate \( 10^\circ/\text{m} \), while the right end is kept at \( 0^\circ \). Suppose that initially the entire rod is at \( 0^\circ \). Use your simulation to determine the temperature of the rod after 10 minutes have elapsed. What is the value of the temperature at the center of the rod?

Write a good report of your findings, including
- What is the mathematical model of the problem?
- What is the numerical method used to solve the problem?
- What is the structure of your program?

When answering these questions, it is essential that you address the question of how the choice of step size affects the result. You must run the simulation for different step sizes to draw correct conclusions.

Your grade for the project will be based on the following criteria:
- The quality of your program
- The accuracy of your answers to 1. and 2.
- The quality of your written report.