UNIVERSITY OF NOTRE DAME
Department of Aerospace and Mechanical Engineering

AME 30314

NUMERICAL PROJECT I

Due: Beginning of Period, Wed Dec 7, 2022

1. The 1-D unsteady heat conduction equation, when appropriately non-dimensionalized has the form,

$$\frac{\partial T}{\partial t} = \frac{\partial^2 T}{\partial x^2}$$

Write a computer program to solve this equation using the explicit, forward-time, centered space algorithm under the following condition:

(a) $T(x,0) = \sin(\pi x), \qquad T(0,t) = T(1,t) = 0;$

(b) $T(x,0) = 1, \qquad T(0,t) = \frac{\partial T}{\partial t}(1,t) = 0;$

For the purpose of comparison, you have obtained the analytical solutions for cases (a) and (b) in Homework #7.

As pointed out in class, the truncation error for this numerical scheme is $O\left(\Delta t,(\Delta x)^2\right)$. Check to see if this is reflected in your calculations. What happens when the time step is near $\Delta t = (\Delta x)^2 / 2$? What happens when $\Delta t > (\Delta x)^2 / 2$?

Your solution to this problem should include the following: (1) a brief description of the problem (governing equation, initial and boundary conditions and their physical interpretations). (2) a description of the numerical approach, (3) commented code listing, 4 (solution with appropriate plots showing the evolution of the temperature distribution with time as well as a comparison with the analytical solutions, 5 a discussion summarizing your results.