

Computer Assignment Number 1

Due: Feb. 20, 11:59 PM

Numerical and Analytical Solutions to Parabolic Partial Differential Equations: prerequisite for solving boundary layer problems

For the following parabolic partial differential equation

$$\frac{\partial u}{\partial x} - 2 \frac{\partial^2 u}{\partial y^2} = 2 \quad (1)$$

The boundary conditions for u is

$$u(x, 0) = 0, \quad u(x, 1) = 0$$

The “initial” conditions for u is

$$u(0, y) = 0$$

1. Derive the analytical solution of the parabolic equation with given initial and boundary conditions.
2. Use the Crank-Nicholson Scheme and Central Difference Scheme to discretize the equation. You can either use a finite-volume based method or a finite-difference based method.
3. Find the numerical solution of Eq. 1 and compare with the analytical solution. Use LU decomposition as the linear system solver.

Other requirements:

1. Preferred programming language for this project is Python, Matlab, FORTRAN or C or C++. Please consult the instructor if you plan to use other languages.
2. A modular programming practice is highly recommended. It is suggested that separate modules/subroutines/functions are written for each functionality you plan to achieve. For example, one module/section for setting parameters, one module/section for setting the right-hand-side-of equations, one module/section for solving the linear system, and one module/section for postprocessing the data, etc.. The modular programming practice can facilitate the debugging process, and is almost mandatory for collaborative development of large code systems.

ME 5311: Computer Project #1: Grade Sheet

Item	Score
Description of the problem	/01
Description of the numerical method	/03
Derivation of the analytical solution	/03
Presentation of results	
Profiles at different x locations from numerical solution	/04
Profiles at different x locations from analytical solution	/03
Discussion of results	
General description	/01
Accuracy and stability	/01
Appendix – copy of program listing	
Structure	/02
Documentation	/02
	Total: /20