Abstract ID: P04

NUMERICAL SOLUTION AND STABILITY ANALYSIS OF ONE-DIMENSIONAL HEAT EQUATION

M.M. Zathiha*, M.A.A.M. Faham

Department of Mathematics, Faculty of Applied Sciences,
South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka.

**zathiha@gmail.com*

Abstract

In a variety of scientific domains, the heat equation has many fundamental importance. Heat is a type of energy that can be found in any substance. The physical phenomena of the one-dimensional heat equation were investigated in this research study by generating the model with Dirichlet boundary conditions and initial conditions. This model was solved using the numerical method of finite difference of the explicit Forward Time Centered Space (FTCS) and implicit Backward Time Centered Space (BTCS) schemes, derived from the Taylor series expansion for the required orders. Then we have interpreted the basic behaviour of the numerical solutions of the derived model with diverse initial conditions of trigonometric function, polynomial function, exponential function, and piece-wise function. For these four illustrative test example problems, we also have considered and compared on the stability criteria of the numerical results for the produced solutions using the Von-Neumann stability analysis techniques. From the solutions, we have found that the explicit FDM – FTCS method is very easy to calculate numerically and show the stability only for $r \leq 0.5$. Whereas implicit FDM - BTCS method is unconditionally stable and computer time required at each step is higher. In addition, the simulation method is utilized to assess performance based on accuracy and programming implementations in MATLAB with two-dimensional and three-dimensional graphical representations employed for various time steps and stability requirements. Where we can conclude the stability criteria are met when the parameters are changed to meet the desired criteria.

Keywords: *one-dimensional heat equation, explicit and implicit finite difference method, Von-Neumann stability analysis*