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Introduction to Numerical Methods in Engineering Applications

R.C. Mohanty
Department of Mechanical Engineering,
Centurion University of Technology and Management,
Bhubaneswar, Odisha, India
Email:- rcmohanty@cutm.ac.in

Abstract: Even though the classical technique precisely exhibits the actual scenario thereby offering an exact solution, but its application is limited to simple and standard problems. Indeed, many real life engineering problems are of very complex geometry with arbitrary load, boundary and support conditions. The analysis in that situation is either too hard or almost impossible to solve by classical method. In view of this, many numerical methods can be applied to solve all kinds of engineering problems producing an approximate solution. Finite Difference Method (FDM), Finite Element Method (FEM) and Finite Volume Method (FVM) are some numerical methods available to solve structural dynamics, solid mechanics, heat transfer, fluid flow, electromagnetic problems, etc. Mostly all numerical methods need computer application based on which many commercial software packages are used in industrial, research and academic institutions to solve many practical problems related to science and engineering. Over last few decades, the development of high and low cost computer has enhanced the scope on the application of numerical methods to analyze engineering and scientific problems. The main objective of this chapter is to discuss the above three numerical techniques and their approaches with theoretical background to solve almost every type of problem.

Keywords: Numerical methods, FDM, FEM, FVM, approximate solution

1. Introduction

The analytical approach is often appreciated to solve any engineering problem consisting of a governing differential equation because it yields exact result. However, its application is either too difficult or impossible in solving many real life problems. This may be due to mathematical difficulty for irregular geometry, multiple materials, anisotropic material property and other linearity. In those situations where analytical solution is not possible, any numerical procedure can be used producing an approximate solution, i.e. a nearly exact solution. Numerical approach does not produce a closed-