

## CHAPTER-VI

### Numerical Solution of Ordinary Differential Equations

#### 6.1 Introduction

Differential equations are equations composed of an unknown function and its derivatives. The following are examples of differential equations:

$$\frac{dv}{dt} = g - \frac{c}{m} v \quad (6.1a)$$

$$m \frac{d^2 x}{dt^2} + c \frac{dx}{dt} + kx = 0 \quad (6.1b)$$

Differential equations can be classified as *ordinary differential equations* (ODE) or partial *differential equations* (PDE). ODEs are equations in which the function involves *one* independent variable. PDE's involve functions two or more variables. Both Eq.(6.1a) and Eq.(6.1b) are ordinary differential equations. Differential equations are also classified as to their order. For Eq.(6.1a) is a first-order equation because the highest derivative is a first derivative. A second order equation includes a second derivative, as in Eq. (6.1b) above. Similarly, an  $n^{\text{th}}$  order equation includes an  $n$ th derivative.

This chapter is devoted to solving ordinary differential equations of the form

$$\frac{dy}{dx} = f(x, y) \quad (6.2)$$

One-step Runge-Kutta (RK) methods can be generally expressed as

$$y_{i+1} = y_i + \phi h \quad (6.3)$$

According to this equation, the slope estimate of  $\phi$  is used to extrapolate from an old value  $y_i$  to new value  $y_{i+1}$  over a distance  $h$ . This formula can be applied step by step to compute values of  $y$ . The simplest approach is to use the differential equation to estimate the slope in the form of first derivative at  $x_i$ .

#### 6.2 Euler's Method

The first derivative provides a direct estimate of the slope at  $x_i$ . That is,

$$\phi = f(x_i, y_i) \quad (6.4)$$

where  $f(x_i, y_i)$  is the differential equation evaluated at  $x_i$  and  $y_i$ . This estimate can be substituted into Eq. (6.3):

$$y_{i+1} = y_i + f(x_i, y_i)h \quad (6.5)$$

This formula is referred to as *Euler's method*.

# Students Solution Manual For Ordinary Differential Equations

**K. F. Riley, M. P. Hobson**



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**Ordinary Differential Equations** Jane Cronin, 1994-02-15 This text now in its second edition presents the basic theory of ordinary differential equations and relates the topological theory used in differential equations to advanced applications in chemistry and biology It provides new motivations for studying extension theorems and existence theorems supplies real world examples gives an early introduction to the use of geometric methods and offers a novel treatment of the Sturm Liouville theory

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*Differential Equations and Boundary Value Problems* John A Banks, 1993 **Ordinary Differential Equations** William A. Adkins, Mark G. Davidson, 2012-07-01 Unlike most texts in differential equations this textbook gives an early presentation of the Laplace transform which is then used to motivate and develop many of the remaining differential equation concepts for which it is particularly well suited For example the standard solution methods for constant coefficient linear differential equations are immediate and simplified and solution methods for constant coefficient systems are streamlined By introducing the Laplace transform early in the text students become proficient in its use while at the same time learning the standard

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