

Lecture-1

Errors in Numerical Calculations

The main objective of this course is to provide computer-oriented, efficient and reliable numerical methods for solving problems arising in different areas.

we will address the following methods —

1) Algebraic and Transcendental Equation \Rightarrow

The problem of solving non-linear equations of the type $f(x) = 0$ is frequently encountered in rocket studies.

for example —

the equation —

$$\frac{M_0}{M_0 - U_f t} = e^{(u+gt)/u_0}$$

is a non-linear equation for t when M_0 , g , u , u_0 and U_f are given.

2) matrices and linear systems \Rightarrow .

The problem of solving systems of linear algebraic equations and the determination of eigenvalues and eigenvectors of matrices are major problems of disciplines such as differential equations, fluid mechanics, theory of structures etc.

3) Interpolation \Rightarrow

Given a set of data values (x_i, y_i) , $i = 0, 1, 2, \dots, n$ of a function $y = f(x)$, where the explicit nature of $f(x)$ is not known, it is often required to find the value of y for a given value of x , where $x_0 < x < x_n$. This process is called interpolation. If this process is carried out for functions of several variables; it is called multivariate interpolation.

4). Numerical differentiation and Integration \Rightarrow

It is often required to determine the numerical values of -

(i) $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$, ... for a certain value of

$$x \text{ in } x_0 \leq x \leq x_n$$

(ii) $I = \int_{x_0}^{x_n} y \cdot dx$

where the set of data values (x_i, y_i) , $i = 0, 1, \dots, n$ is given, but the explicit nature of $y(x)$ is not known. for example, if the data consist of angle θ (in radians) of a rotating rod for values of time t (in seconds), then its angular velocity and angular acceleration at any time can be computed by numerical differentiation formulae.

4.

5) Ordinary and partial differential Equations \Rightarrow

Engineering problems are often formulated in terms of an ordinary or a partial differential Equation.

for example \Rightarrow The mathematical formulation of a falling body involves an ordinary differential equation and the problem of determining the steady-state distribution of temperature on a heated plate is formulated in terms of a partial differential equation. In most cases, exact solutions are not possible and a numerical method has to be adopted. In addition to the finite difference methods, this book also presents a brief introduction to the cubic spline method for solving certain partial differential equations.