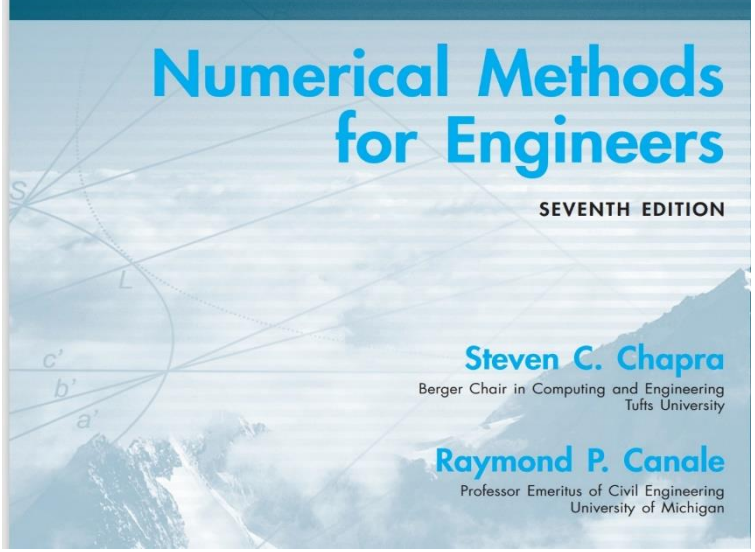


Engineering Numerical Analysis 0904302 Mechanical Engineering The University of Jordan Second 2023-2024

Introduction
Numerical Analysis

Numerical methods are techniques " computer methods" by which mathematical problems are formulated so that they can be solved with arithmetic operations "arithmetic calculations".

Non-computer Methods:

1. Analytical
2. Graphical
3. Calculator (slide-Ruler)

Numerical Methods are techniques by which mathematical problems are formulated and then solved with arithmetic operations (addition, subtraction, multiplication and division). The numerical methods:

1) Involve thousands of arithmetic operations deal with numbers.
2) They are capable of handling large systems of equations and non-linear equations which cannot be solved analytically.
3) They are an efficient tools for learning computer programming as well as mathematics.

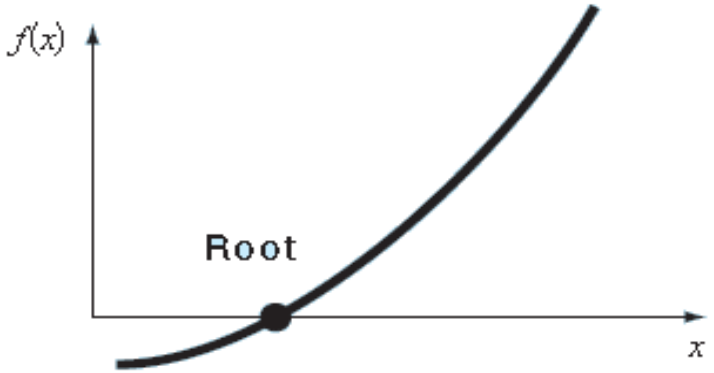
Error is the discrepancy between the exact (analytical) solution and the numerical solution which involve approximation. In numerical methods, the error should be reduced and limited as much as possible.

Why we should study Numerical Analysis?

1. Numerical methods are extremely powerful problem-solving tools. They are capable of handling large systems of equations, nonlinearities, and complicated geometries that are often impossible to solve analytically.
2. Use commercially available prepackaged, computer programs that involve numerical methods. The use of these programs is often predicated on knowledge of the basic theory underlying the methods.
3. Design your own programs to solve problems without having to buy or commission expensive software.
4. Numerical methods are an efficient vehicle for learning to use computers.
5. Numerical methods provide a vehicle for you to reinforce your understanding of mathematics.

Summary of the topics covered in the text:

(a) *Part 2:* Roots of equations
Solve $f(x) = 0$ for x.

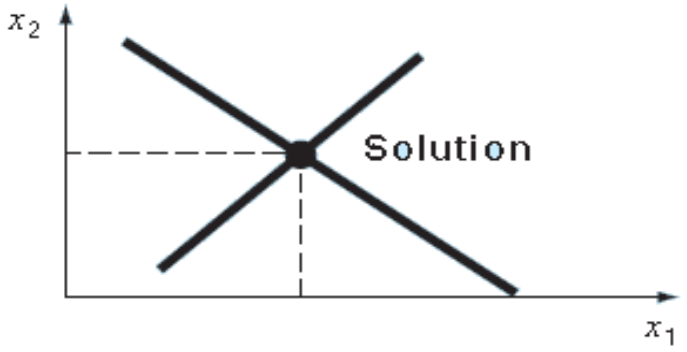


(b) *Part 3:* Linear algebraic equations
Given the a's and the c's, solve

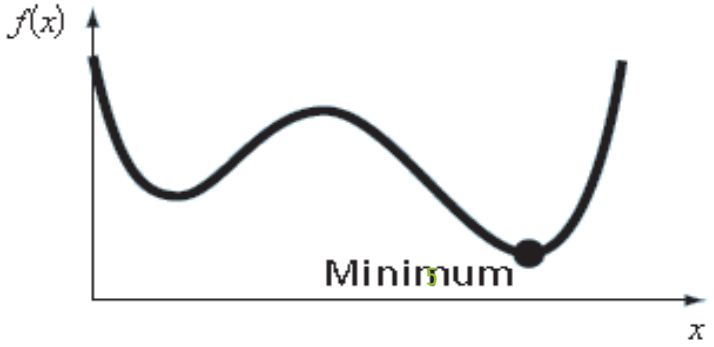
$$a_{11}x_1 + a_{12}x_2 = c_1$$

$$a_{21}x_1 + a_{22}x_2 = c_2$$

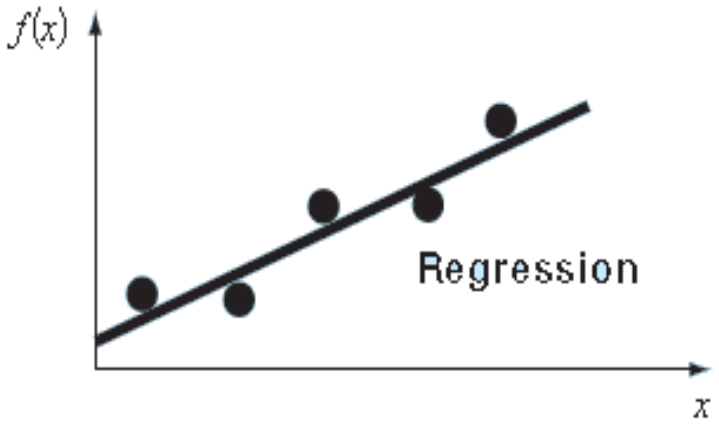
for the x's.

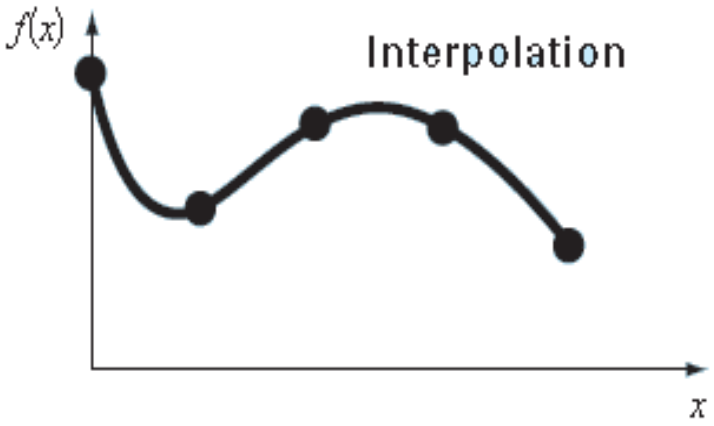


(c) *Part 4:* Optimization
Determine x that gives optimum $f(x)$.



(d) *Part 5:* Curve fitting

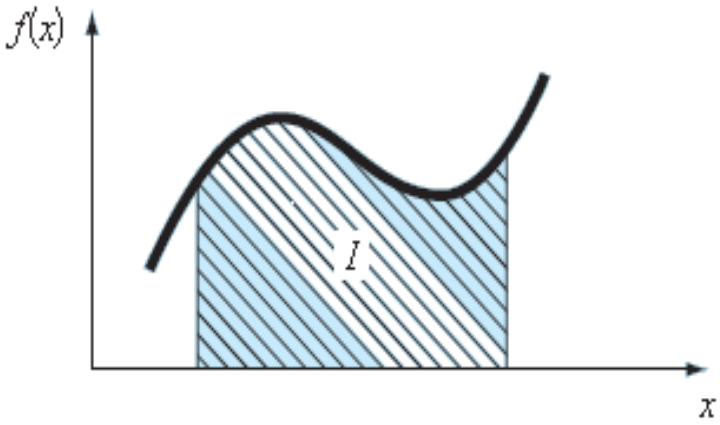




(e) *Part 6:* Integration

$I = \int_a^b f(x)\,dx$

Find the area under the curve.



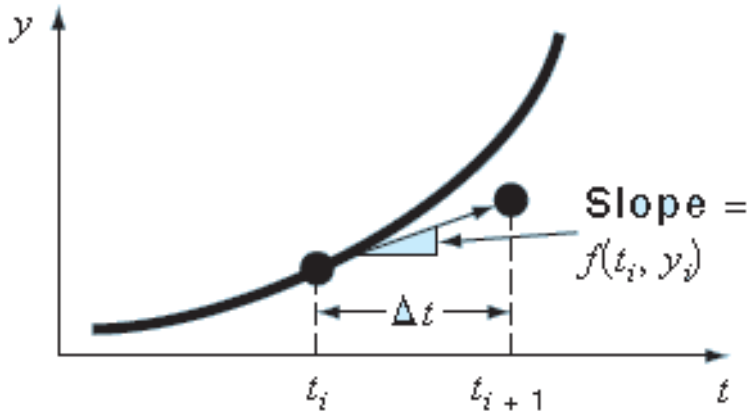
(f) *Part 7:* Ordinary differential equations

Given

$$\frac{dy}{dt} \simeq \frac{\Delta y}{\Delta t} = f(t, y)$$

solve for y as a function of t.

$$y_{i+1} = y_i + f(t_i, y_i)\,\Delta t$$



(g) *Part 8:* Partial differential equations

Given

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f(x, y)$$

solve for u as a function of x and y