### ME 261: Numerical Analysis

### Lecture-1: Introduction

Md. Tanver Hossain Department of Mechanical Engineering, BUET <u>http://tantusher.buet.ac.bd</u>

# Introduction

#### Most Engineering analysis problems involve-

 The development of a mathematical model (Theoretical Model) to represent all the important characteristics of the physical system
The derivation of the governing equations of the model by applying physical laws such as Newton's law of motion, conservation of mass, conservation of momentum and conservation of energy
Solution of the governing equations (Mathematical Problem)
Interpretation of the solution.

Depending on the system being used, the governing equations may be a set of linear and non linear algebraic equations, a set of transcendal equations, a set of ordinary or partial differential equations, or an equation involving integrals or derivatives.



## Introduction

Solution of governing equations may or may not be able to find in analytical form. Analytical solutions denote exact solutions that can be used to study the behavior of the system with varying properties.

Numerical solutions are those that can not be expressed in the form of mathematical expressions.

$$I_{1} = \int_{a}^{b} x e^{-x^{2}} dx = \frac{1}{2} (e^{-a^{2}} - e^{-b^{2}})$$
 Analytic Solution  
$$I_{2} = \int_{a}^{b} e^{-x^{2}} dx = ???$$
 No Analytic Solution  
Can only be evaluated numerically



## Introduction

One of the Millennium Problems

Governing equations for Fluid Dynamics are-1. Conservation of mass2. Conservation of Momentum



Solution of such complicated system of equations can not be solved analytically. **Numerical solution is a must**.



#### **Introduction** WHY NUMERICAL ANALYSIS ?

-Numerical methods are capable of handling large systems of equations, nonlinearities, and complicated geometries that are not uncommon in engineering practice and that are often impossible to solve analytically.

-The intelligent use of computer programs is often predicated on knowledge of basic theory underlying the methods.

-Many problems cannot be approached using commercially available computer programs, so if you are adept of programming , you can design your own programs to solve problems.

-It is well known that an effective way to learn programming is to actually write computer programs, so it is a good opportunity to apply what you have already learned in **MatLab**.



# **Course Content**

- 1. Approximations and Errors in Numerical Computations
- 2. Roots of Equations
- 3. Solution of Sets of Linear and Non-Linear Algebraic Equations
- 4. Solution of Sets of Homogeneous Equations
- 5. Curve Fitting
- 6. Interpolation Methods
- 7. Numerical Differentiation
- 8. Numerical Integration
- 9. Solution of Differential Equations



# **Text Book**

**1.** Numerical Methods for Engineers - Steven C. Chapra and Raymond P. Canale

#### **Reference Books**

1. Numerical Analysis (7th Edition)

- Richard L. Burden and J. Douglas Faires
- 2. Applied Numerical Analysis (6th or Latest Edition)
- Curtis F. Gerald and Patrick O. Wheatly

3. Class Lectures

