LECTURE - 1

CE 601 NUMERICAL METHODS

24-JULY-2012

Introduction

* We are all engineers
* We may have seen or have to solve various engineering problems and also design various engineering projects
* For example in civil engineering - you have problems associated with structural engineering, geo-technical engineering, fluid mechanics, hydrology, environmental engineering, transportation engineering etc.
* Some obvious examples
  - → Deflection in a beam
  - → Stiffness of a column structure
  - → Foundation design
  - → Determination of pressure head in pipe flows
  - → Pipe networks
  - → Vehicle density in a road, etc.
  - → Waste-water treatment, etc.
* How will you approach to solve such problems.
* For that you require a good background knowledge on the subject or the theory.

→ Consider the example of a particle thrown up:

↳ A particle is thrown up with a velocity v_0.

↳ It goes up and stops and then falls down.

↳ The theory behind this, you are aware from your school days.

↳ Here physical variables like velocity, acceleration, distance, time, etc. comes into picture.

→ One can now ~~represent~~ mimick this phenomena using certain expressions.

↳ i.e. There is no need to do the experiment further

↳ You will be able to get the height or distance the particle travelled before it falls down.

$$s = v_0 t + \frac{1}{2} a t^2 \quad \rightarrow (1)$$

Eqn. (1) is a mathematical expression for the distance travelled.

Equation (1) is therefore called <u>mathematical model</u> for the distance travelled by the particle.

→ Similarly there are various natural and engineering phenomena that can be mathematically modelled using :

- → Algebraic equations
- → Ordinary Differential equations
- → Partial Differential equations
- → Trigonometric functions etc.

e.g. In the case mentioned earlier in physics, it is defined

$$\left.\begin{aligned} a &= \frac{dv}{dt} \\ \text{and} \quad v &= \frac{ds}{dt} \\ \therefore \quad a &= \frac{d^2s}{dt^2} \end{aligned}\right\} \rightarrow (2)$$

→ The set of equation (2) is also a differential equation.

Differential equations

~~It~~ ons Used to mathematically model various phenomena.

→ Consist of independent variables
dependent variables

e.g. $$\frac{d^2y}{dt^2} + A\frac{dy}{dt} + By = C \rightarrow (3)$$

If there is an expression in differential form
→ It has to be solved.
→ Solution can be obtained by:

* Analytical methods
* Graphical methods
* Approximations like Numerical Methods.

Numerical Methods

Therefore Num. Methods is that branch that deals with the approximate way of finding solutions to various mathematical problems.

Analytical Methods → Maybe quite difficult and possible for simple conditions

Graphical → Quite tedious

In this age of computers, therefore, numerical methods have found a significant role in solving various engineering and scientific problems.

→ As suggested, computers have ~~signed~~ important role.
Therefore, the following properties are important:

Significant Digits

Consider $\pi = \frac{22}{7} = 3.1415926535\ldots$

It is difficult to express all the digits in computer. You need to specify upto which digit you will consider.

Precision

Accuracy → governed by errors in numerical approximations

Errors

- → Errors in the parameters of the problem
- → Algebraic errors
- → Iteration errors
- → Approximation errors
- → Roundoff errors

You will have engineering problems consisting of

(i) Systems of linear Algebraic equations

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n &= b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n &= b_2 \\ \vdots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n &= b_n \end{aligned}$$

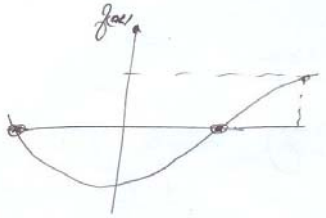
You might have seen such system of equations in structural design, etc.

(ii) Eigen Problems

→ If your system of algebraic equations is homogeneous — case Eigen value problem.

(iii) Roots of Non-linear equations

$f(x) = 0$



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