ME 704
Computational Methods in Thermal and Fluids Engineering
(Introduction)

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General-1

Motivation for study

- ❑ To introduce numerical algorithms for solving thermal engineering problems

Instructor

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Grading

- ❑ Mid-Sem: 30%
- ❑ End-Sem: 40%
- ❑ Assignments: 30%

General-2

Books

- ❑ Numerical Methods for Engineers, Chapra and Canale,
- ❑ Applied Numerical Methods, Akai
- ❑ Computational Fluid Dynamics, Hoffman and Chiang
- ❑ Computational Fluid Dynamics, Ferziger and Peric

General-3

Emphasis

- ❑ Engineering rather than mathematical,
- ❑ Fundamentals to be stressed
- ❑ Theorems and Lemmas not be stressed but just mentioned
- ❑ General concepts to be stressed than very specific ones
- ❑ Extensive use of computers will be the focus

Material to be covered

- Single non-linear equation
- System of linear and non-linear equations
- Interpolation, extrapolation and regression
- Differentiation and integration
- ODEs including IVP and BVP
- PDEs involving parabolic, elliptic and hyperbolic systems

Scope of Numerical methods

Problem solving methods in TFE

- Analytical
  - Needs complex mathematics
- Experimental
  - Limited validity
  - Expensive and Time consuming
- Numerical
  - Simple to apply
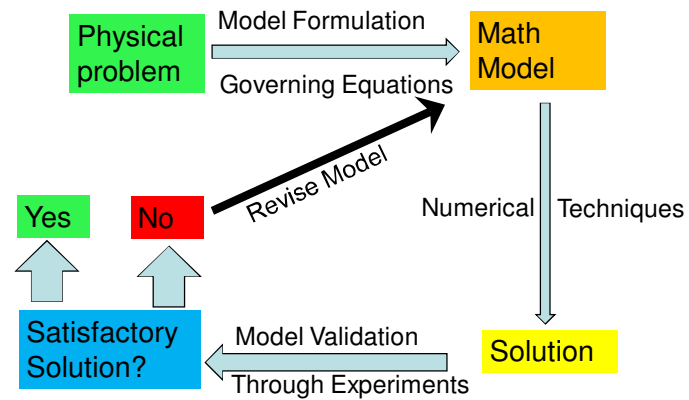 - Quick and economical

Advantages of Numerical methods

- Complex problems can be solved with modest mathematical background
- Large parametric solutions can be obtained economically to reinforce the physical understanding
- Graphical visualization possible to locate hot spots, high velocity zones, etc.

Goals and Objectives

- To give exposure to wide spectrum of methods
- To instill confidence in problem solving skills
- To prepare students for their research problem that can be numerically

Problem Solving Methodology

Physical problem → *Model Formulation / Governing Equations* → **Math Model**

Math Model → *Numerical Techniques* → **Solution**

Solution → *Model Validation Through Experiments* → **Satisfactory Solution?**

Satisfactory Solution? → **Yes** / **No**

No → *Revise Model* → Math Model

Elements of Numerical Solution

Algorithm Design
- ❑ Aim of the course

Program Implementation
- ❑ Students to learn independently through weekly homework

Debugging and Testing
- ❑ Benchmark problems to be utilised

Documentation, Storage and Retrieval
- ❑ Should have a clear write-up, stored in multiple DVD

General Tips

- ❑ Programs should be structured
- ❑ Should have several comment statements
- ❑ Should be modular and made of several functions and subroutines
- ❑ Should use structured blocks such as,
  IF-THEN-ELSE-ENDIF
  DO-ENDDO
- ❑ Should not assume to converge