Applied Numerical Methods

Lecturer:
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Alternative Names:

- Numerical Computation
- Numerical Analysis
- Numerical Methods
Course Definition:

- Solve Mathematical Problem with Arithmetic Operations.
- Efficient Digital Computers increase role of Numerical Methods, dramatically.
Why Numerical Computation (1)

- Problems with non-analytical solution, for example:
  - Integral: \[ I = \int_0^1 e^{-t^2} \, dt \]

- Problems with non-closed form, for example:
  - Differential Equation: \[ y''(t) + \sin(t)(y'(t))^2 + t^2y = e^{-t^2} \]
  - Polynomial roots: \[ x^4 + x + 1 = 0 \]
Why Numerical Computation (2)

- **Large Scale Problems:**
  - Large Systems on Equations (Even with analytical Solution), for example:
    - Algebraic Systems: \( AX = B, \ A_{1000 \times 1000} \)

- **Problems with non-exact solution:**
  - Algebraic Systems: \( AX = B, \ A_{900 \times 1000}, X_{1000 \times 1}, B_{900 \times 1} \)

- **Hardware Implementation!**
Why Numerical Computation (3)

- Understand the Basic Theory Underlying the methods in Available Package.
  - MATLAB
  - MATHEMATICA
Course Syllabus (1)

- **Errors and Numbers Representation**
  - Fixed Point
  - Floating Point

- **Roots of Nonlinear Equations**
  \[ x^7 + \sin(x) - \ln(x) = 0 \]

- **Interpolation**
  \[
  \begin{align*}
  \{x_1, x_2, \ldots, x_n\} & \implies f(x) = ? \\
  \{y_1, y_2, \ldots, y_n\}
  \end{align*}
  \]

- **Numerical Differentiation**
  \[ f(\theta) = \exp\left(\frac{\sin(\cos \theta)}{\cos(\sin \theta)}\right) \]
Course Syllabus (2)

- **Numerical Integration (1D/2D)**
  \[ \int_{0}^{\pi} \sqrt{1 + a^2 \cos^2 \theta} \, d\theta \]

- **Numerical Solution of Ordinary Differential Equations.**
  \[ x''(t) + x^2(t) = \sin(t) \]

- **Matrices Manipulation:**
  - Linear Systems Solution
  - Determinants
  - Inversion
  - Eigenvalues and Eigenvectors

- **MontCarlo Methods**
References:

- Applied numerical methods using MATLAB, W. Y. Yang and etc.
- Numerical Mathematics and Computing, W. Cheney & D. Kincaid
- Computational Mathematics, B.P. Demidovich and I.A. Moran.
- Applied Numerical Analysis, Gerald and Wheatley.
- Numerical Methods Using MATLAB, J.H. Mathews and K.D. Fink
- Applied Numerical Methods for Engineers Using Matlab and C, Schilling and Harris
- Numerical Methods With MATLAB: Implementation Application, G. Recktenwald
Course Homepages:

http://sina.sharif.edu/~fatemizadeh/Courses/ANA/ANA.html
Evaluation

- Middle Exam: 40% (8 of 20) 30% (6 of 20)
- Final Exam: 40% (8 of 20) 65% (13 of 20)
- Homework (Paper+Code): 20% (4 of 20) 5% (1 of 20)
- Homework Submission rules:
  - An email to iau.course@gmail.com with this typically subject: ANAO{n:studentnumber}
- Where n is Homework number.