Math 116: Numerical analysis

ORC syllabus

Many mathematical models arising in various applications cannot be solved analytically. This course teaches fundamentals of numerical analysis, and focuses on how numerical algorithms are constructed and analyzed in terms of their accuracy, efficiency, stability, conditioning, and convergence properties. Students will use MATLAB to demonstrate the validity and/or failure of various approaches in different situations.

The topics of the course will alternate between odd and even years. In odd years, the main focus will be on numerical linear algebra, and include the study of least squares methods, iterative methods for linear systems, eigenvalue problems. Other topics will include root finding methods and optimization. In even years, the focus will be on numerical ordinary and partial differential equations, including both linear and non-linear problems. Numerical interpolation, differentiation, integration, and approximation techniques will also be discussed as they pertain to solving differential equations.

Odd years:

References.

1. *A First Course in Numerical Methods* by Ascher and Grief.
2. *Numerical Linear Algebra*, by Trefethen and Bau.
3. *Numerical Mathematics*, 2nd edition, by Quarteroni, Sacco, and Saleri.
4. *Numerical Analysis*, 9th edition, by Burden and Faires.
5. *Numerical Linear Algebra: An Introduction*, by Holger Wendland.
6. *Explorations in Numerical Analysis*, by Lambers and Sumner.

Numerical analysis.

1. Understanding error, stability and conditioning
2. Nonlinear equations in one variable
3. Direct methods for solving linear systems
4. Iterative methods for solving linear systems
5. Calculation of Eigenvalues

6. Compressive Sensing

Even years:

References.

1. *A First Course in Numerical Methods* by Ascher and Grief.
2. *Numerical Mathematics*, 2nd edition, by Quarteroni, Sacco, and Saleri.
3. *Numerical Analysis*, 9th edition, by Burden and Faires.
4. *Finite Difference Methods for Ordinary and Partial Differential Equations, Steady State and Time Dependent Problems* by Randall Leveque (ISBN: 978-0-898716-29-0).
5. *Finite Volume Methods for Hyperbolic Problems* by Randall Leveque (ISBN: 978-0-521-00924-9).
6. *Finite Difference Schemes and Partial Differential Equations*, Second Edition by John Strikwerda (ISBN: 0-89871-567-9).

Numerical analysis.

1. Numerical interpolation and approximation.
2. Numerical differentiation and integration.
3. Numerical methods for ordinary differential equations.
4. Numerical methods for partial differential equations (hyperbolic and parabolic).