Numerical methods for PDEs

Spring 2018

Instructors:	Dr. Saul Daz Infnte Dr. Jairo Rodrguez Padilla Dr. Daniel Olmos Liceaga	**Time:**	Tu, Th 16:00–18:00
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Course Pages:

1. https://github.com/cpraveen/chebpy
2. http://cpraveen.github.io/teaching/chebpy.html
3. https://sauldiazinfantevelasco.wordpress.com/
4. https://github.com/SaulDiazInfante/spectral-methods.git

Office Hours: After class, or by appointment.

Main References: This is a restricted list of various interesting and useful books that will be touched during the course. You need to consult them frequently.

- Trefethen, Lloyd N. Spectral Methods in MATLAB (Software, Environments, Tools). Philadelphia, PA: Society for Industrial and Applied Mathematics, 2001. ISBN: 9780898714654.
- LeVeque, Randall J. Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-Dependent Problems. Philadelphia, PA: Society for Industrial and Applied Mathematics, 2007. ISBN: 9780898716290.
- Canuto, Claudio S., M. Y. Hussaini, A. Quarteroni, and T. A. Zang. Spectral Methods Evolution to Complex Geometries and Applications to Fluid Dynamics.

Description: This course addresses under-graduate students of mathemmatics and computational sciences who are interested in numerical methods for partial differential equations, with focus on a rigorous mathematical basis. Many modern and efficient approaches are presented, after fundamentals of numerical approximation are established. Of particular focus are a qualitative understanding of the considered partial differential equation, fundamentals of finite difference and spectral methods, and important concepts such as stability, convergence, and error analysis.

Problems: Problems: advection equation, heat equation, wave equation, convection-diffusion problems, KdV equation, hyperbolic conservation laws, Poisson equation.

Concepts: Concepts: consistency, stability, convergence, Lax equivalence theorem, error analysis, Fourier approaches, front propagation, preconditioning, multigrid, Krylov spaces.

Methods: finite differences, spectral methods, direct and iterative methods, multigrid.

Tentative Course Outline:

1. Diferentiation Matrices
2. Unbounded Grids: The Semi-Discrete Fourier Transform
3. Periodic Grids: The DFT and FFT
4. Smoothness and Spectral Accuracy
5. Polynomial Interpolation and Clustered Grids
6. Chebyshev Diferentiation Matrices
7. Boundary Value Problems
8. Chebyshev Series and the FFT
9. Eigenvalues and Pseudospectra
10. Time-Stepping and Stability Regions
11. Integrals and Quadrature Formulas

Grading Policy:

- Homework and quizzes (50%),
- Final Project (50 %): Pycuda implementation of a spectral method for a 1-D PDEs prblem.

Class Policy:

- Regular attendance is essential and expected.