

Topics in Applied Mathematics

Spring 2012, ACMS 80770

Instructor: Dr. Yongtao Zhang (yzhang10@nd.edu)

Class time and location: MWF 10:40-11:30am, DBRT 232

Office location: HAYE 242

Office phone: (574) 631-6079

Office hours: Thursday 2:00pm – 4:00pm, or by appointment.

Textbook: None

Pre-requisite: graduate-level Numerical Analysis, undergraduate-level partial differential equations

Course description: The course will emphasize several high order accurate numerical methods for solving partial differential equations (PDEs). Algorithm design, analysis and implementation will be discussed. Topics include weighted essentially non-oscillatory (WENO) finite difference and finite volume methods for hyperbolic conservation laws and Hamilton-Jacobi equations, discontinuous Galerkin (DG) finite element methods for convection-dominated equations and PDEs containing higher-order spatial derivatives, and numerical methods for advection-reaction-diffusion equations. Applications of these numerical methods to physical and biological problems will be discussed.

References:

- [1] C.-W. Shu, **Essentially Non-Oscillatory and Weighted Essentially Non-Oscillatory Schemes for Hyperbolic Conservation Laws**, in *Advanced Numerical Approximation of Nonlinear Hyperbolic Equations*, B. Cockburn, C. Johnson, C.-W. Shu and E. Tadmor (Editor: A. Quarteroni), *Lecture Notes in Mathematics*, volume 1697, Springer, 1998.
- [2] B. Cockburn, **Discontinuous Galerkin methods for convection-dominated problems**. In: Barth, T.J., Deconinck, H. (eds.) *High-Order Methods for Computational Physics*. *Lecture Notes in Computational Science and Engineering*, vol. 9, pp. 69–224. Springer, Berlin (1999).
- [3] C.-W. Shu, **Discontinuous Galerkin methods: general approach and stability**, *Numerical Solutions of Partial Differential Equations*, S. Bertoluzza, S. Falletta, G. Russo and C.-W. Shu, *Advanced Courses in Mathematics CRM Barcelona*, Birkhauser, Basel, 2009, pp.149-201.
- [4] W. Hundsdorfer and J. Verwer, **Numerical Solution of Time-Dependent Advection-Diffusion-Reaction Equations**, Springer-Verlag, 2003.