

CSC2302H – Numerical Solution of Initial Value Problems for Ordinary Differential Equations

Fall Term 2010

Instructor: Wayne Enright, enright@cs.utoronto.ca, 416-978-5474, Ba 4224

Lectures: Tuesday 9-11 in WB 130.

Office hours: TBA

Textbook: U.M. Ascher and L.R. Petzold, *Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations*, SIAM 1998.

Other references: check the webpage of the course for other related books.

Course description (from the academic calendar): Issues involved in the numerical solution of initial value problems in ODEs. Error propagation and the design of robust numerical methods. Methods designed for stiff and non-stiff problems will be reviewed and the significant difficulties arising in each area identified. State-of-the-art software will be surveyed and critically evaluated. Difficulties associated with implicit equations, algebraic constraints and delay terms will also be considered.

Course Outline :

1. Mathematical Background and Numerical Implications – [4 hours]
 - (a) solution of perturbed systems
 - (b) the defect of a numerical solution
 - (c) general error bounds for numerical solutions
2. General Properties of Numerical Methods – [4 hours]
 - (a) order/convergence/stability
 - (b) local/global error

3. Standard Classes of Methods – [8 hours]
 - (a) one step (Runge-Kutta)
 - (b) multistep (Adams)
 - (c) survey of existing software
4. Difficulty of Stiffness – [2 hours]
 - (a) where does this difficulty arise
 - (b) related difficulties/bottlenecks
5. Special Methods for Stiff Problems – [2 hours]
 - (a) implicit Runge-Kutta
 - (b) BDF multistep
 - (c) survey of existing software
 - (d) exploiting special structure
6. Differential/Algebraic Equations – [1 hour]
 - (a) where do problems arise
 - (b) special structure and problem classification
 - (c) two basic approaches
 - (d) survey of available methods
7. Delay Differential Equations – [1 hour]
 - (a) where do problems arise
 - (b) mathematical difficulties and implications for numerical methods
 - (c) survey of available methods
8. Validated Numerical Methods – [1 hour]
 - (a) highly reliable vs Guaranteed Accuracy
 - (b) guaranteed error bounds / interval arithmetic
 - (c) limitations and inherent difficulties
9. Other Related Software Tools – [1 hour]
 - (a) global error estimates
 - (b) condition number estimates
 - (c) parameter estimation

(d) sensitivity estimates (of the solution to parameters and of the parameters to the data)

10. Numerical Methods on high-performance systems – [1 hour]

- (a) multicore and parallel architectures
- (b) special formulas
- (c) waveform relaxation
- (d) other approaches

Home page for the course:

<http://www.cs.toronto.edu/~enright/teaching/CSC2302>

Marking Scheme:

3 Assignments at 20% each	60%
1 Project at 40%	40%
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	100%

Schedule:

First lecture - September 14

Last Lecture - December 7

Assignment	Hand-out Date	Due Date	Worth
1	September 28	October 12	20%
2	October 12	November 9	20%
3	November 9	December 7	20%