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

Winter term 2014

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

Lectures: Tuesday 9-11 in Ba 4010.

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 – [2 hours]
    (a) where do problems arise
    (b) mathematical difficulties and implications for numerical methods
    (c) survey of available methods
8. Other Related Software Tools for Investigating IVPs – [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)
9. 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%
	100%

Schedule:
First lecture - January 7
Last Lecture - April 1
Reading Week - February 17 – 21

Assignment	**Hand-out Date**	**Due Date**	**Worth**
1	January 21	February 4	20%
2	February 4	March 4	20%
3	March 4	April 1	20%