

# CSC2322H – Numerical Solution of Boundary Value Problems for Ordinary Differential Equations

## Fall Term 2011

**Instructor:** Wayne Enright, enright@cs.utoronto.ca, (416) 978-5474.

**Lectures:** Tuesday 9-11 in BA 4010.

**Office hours:** Tuesdays and Thursdays: 2:00 - 3:00.

**Textbook:** U.M. Ascher, R.M. Mattheij and R.D. Russell, *Numerical Solution of Boundary Value Problems for Ordinary Differential Equations*, SIAM 1995.

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

## Course description :

The topics include a survey of numerical methods for IVPs, shooting methods, collocation methods and finite difference methods. A presentation of one or more particular areas of difficulty, such as singular perturbation problems, bifurcation problems or parameter fitting, will be included. Issues related to the implementation and effective use of current numerical software will be emphasized.

## Course Outline :

References in parenthesis are to sections of the text.

1. Overview of problem area (1.1, 3.1.1). [1 week]
2. Survey of initial value methods (2.7). [2 weeks]
  - (a) Runge-Kutta
  - (b) Multistep
  - (c) Stiffness
3. Initial-value based BVP methods (4.1, 4.2, 4.3, 4.6). [3 weeks]
  - (a) Shooting methods

- (b) Superposition
- 4. Collocation BVP methods (5.4, 5.6, 9.1,9.2, 9.3). [2 weeks]
  - (a) Derivation
  - (b) Mesh selection
- 5. Finite difference BVP methods (5.1, 5.2, 5.5). [2 weeks]
  - (a) Derivation
  - (b) Extrapolation/deferred correction
- 6. Special difficulties (8.1, 8.3, 8.4, 10.1, 10.2, 11.7, 11.8, 11.9) [3 weeks]
  - (a) Convergence for nonlinear problems
  - (b) Multiple solutions
  - (c) Singular perturbation problems
  - (d) Algebraic constraints
  - (e) Functional differential equations
  - (f) Method of lines
  - (g) Multipoint constraints

**Home page for the course:**

<http://www.cs.toronto.edu/~enright/teaching/CSC2322/index.html>

**Marking Scheme:**

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

**Schedule:**

**First lecture** - September 13

Assignment	Hand-out Date	Due Date	Worth
1	Sept 27	Oct 18	20%
2	Oct 18	Nov 8	20%
3	Nov 8	Dec 6	20%

**Last lecture** - December 6