CSCC51S - Numerical Approximation, Integration and Ordinary Differential Equations **Spring 1999**

Instructor: Daniel Panario, panario@scar.utoronto.ca

Tutor: Nick Cheng, nick@scar.utoronto.ca

Lectures: Mon, Wed 9:10–10:00 in H310.

Tutorial: Fri 1:10–2:00 in H310.

Office hours:

Lecturer: Mondays and Wednesdays 10:10–11:00, and 3:10–4:00 in S-626A.
Tutor: TBA.

Textbook: Richard L. Burden and J. Douglas Faires, "*Numerical Analysis*", Brooks/Cole 1997, 6th edition.

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

Course goals (from the academic calendar): Analysis of methods for approximation, integration and solution of ordinary differential equations. Emphasis on the convergence and stability properties of the algorithms, rather than on their implementation. Prerequisite: CSCC50.

Course Outline (tentative):

1. Interpolation [4 weeks]. Introduction. Polynomial interpolation - Weierstrass theorem. Monomial basis - Vandermonde matrix. Lagrange basis. Newton's basis - Newton's divided differences. Proof of existence and uniqueness of interpolating polynomial. Evaluation of a polynomial - Horner's rule. Error of polynomial interpolation. Polynomial interpolation with derivative data - Hermite interpolation. Langrange basis. Newton's basis - Newton's divided differences. Proof of existence and uniqueness of Hermite interpolating polynomial. Error of Hermite interpolation. Problems with polynomial interpolation - Runge's function. Piecewise polynomial interpolation - splines. Piecewise linear interpolation - error formula. Hermite piecewise cubic interpolation. Cubic spline interpolation - choice of end-conditions. B-spline interpolation

2. Orthogonal Polynomials and Least Squares Approximation [2 weeks]. Weighted least squares problems - discrete and continuous. Inner products and norms of functions. Orthogonal and orthonormal polynomials. Gram-Schmidt algorithm. Best least squares approximation. Tchebychev polynomials.

3. Quadrature Rules [4 weeks]. Introduction, interpolatory rules, Newton-Cotes rules, polynomial degree of a rule, linearity. Midpoint rule and error. Trapezoidal rule and error. Simpson's rule and error. Corrected trapezoidal rule and error. Gauss rules and use of tables, transformation. Compound quadrature rules, introduction. Compound midpoint rule and error. Compound trapezoid rule and error. Compound Simpson's rule and error. Romberg integration. Adaptive quadrature rules. (Semi-)infinite integrals (truncation and translation), singularities (change of variables)

4. Ordinary Differential Equations [3 weeks]. Introduction to ODEs. Stability of ODEs and systems of ODEs, Jacobian, stiff ODEs. Introduction to numerical methods for ODEs. Euler's method. Implicit methods, backward Euler's (BE) and trapezoidal method (TM). Runge-Kutta (RK) methods. Taylor's series methods. Linear Multistep Methods (LMMs).

Home page for the course:

`http://www.cs.toronto.edu/~daniel/teaching/C51/index.html`

Marking Scheme:

4 Assignments at 8% each	32%
1 Term Test at 20%	20%
Final Exam at 48%	48%
	100%

To pass the course, you must receive at least 35/100 on either the final exam or the term test. See the webpage of the course for the policies on plagiarism and lateness.

Additional material will be taught in the tutorials. You are expected to know this material. Graded assignments and test will be handed back by the tutor.

Schedule: **First lecture** - Jan 4

Assignment	Hand-out Date	Due Date	Worth
1	Jan 11	Feb 1	8%
2	Feb 8	Feb 26	8%
3	Mar 1	Mar 19	8%
4	Mar 22	Apr 9	8%

Midterm test - Feb 10 (9:10 in lecture)

Reading week - Feb 15 - 19

Last date to drop - Mar 5

Last lecture - Apr 9

Final exam - Apr 19 - May 7, 1999.