CSCC51H - Numerical Approximation, Integration and ODEs Winter 2012

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Lectures: Mon and Wed 12:00 - 1:00 in IC 326.

There is a weekly tutorial for this course that is currently scheduled for Wednesdays 3:00 - 4:00 in HW 402.

Office hours:

Lecturer: Mondays 3:10 - 4:00 and Wednesdays 2:00 - 3:00 in IC 454.

Textbook: Michael Heath, "*Scientific Computing: an Introductory Survey, 2nd edition*", McGraw-Hill Inc. 2002.

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

Course goals (from the academic calendar): Analysis of methods for the approximation and integration of functions and for the approximate solution of ordinary differential equations. Emphasis is on the convergence and stability properties of the algorithms as well as on their effective use to solve real problems.

Prerequisite: CSCC50H.

Course Outline:

1. General Information and Mathematical background [1week].
   Admin details, What is numerical analysis, Numerical conditioning, Stability of a Problem, Software issues. Mathematical preliminaries: Review of calculus theorems and floating point arithmetic.

2. Interpolation [3 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. Error in polynomial interpolation. Polynomial interpolation with derivative data - Hermite interpolation. Difficulties with polynomial interpolation. Piecewise polynomial interpolation - splines. Piecewise linear interpolation - error formula. Hermite piecewise cubic interpolation. Cubic spline interpolation.

3. Least Squares Polynomial Approximation [1 week].
   Weighted least squares problems - discrete and continuous. Review of QR and/or Gram Schmidt algorithm.

4. Numerical Quadrature [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 transformations. 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. Infinite integrals (truncation and translation), singularities (change of variables).

5. Ordinary Differential Equations [3 weeks].
   Introduction to ODEs. Stability of ODEs and systems of ODEs. Introduction to numerical methods for ODEs. Euler's method. Taylor's series methods. Runge-Kutta (RK) methods. Error control and adaptive stepsize selection.

Home page for the course:

`http://www.cs.toronto.edu/~enright/teaching/C51`

Marking Scheme:

4 Assignments at 10% each	40%
1 Term Test at 20%	20%
Final Exam at 40%	40%
	100%

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

Some additional material will be introduced in the tutorials. You are expected to know this material.

Schedule: **First lecture** - Jan 9

Assignment	**Hand-out Date**	**Due Date**	**Worth**
1	Jan 16	Jan 30	10%
2	Jan 30	Feb 27	10%
3	Feb 27	Mar 12	10%
4	Mar 12	April 4	10%

Midterm test - TBA

Reading week - Feb 20 – 26

Last lecture - April 4