Math 317 Numerical Analysis

Fall 2016

Time: Tuesday and Thursday 8:35AM-9:55AM

Location: ENGMC 204

Instructor: Tiago Salvador
Office: Burnside 1036
Office Hours: Mon 4:30-5:30pm, Wed 1-2pm or by appointment
Email: `tiago.saldanhasalvador@mail.mcgill.ca` (provide "Math 317: ..." in the subject)
Prerequisite:
Ordinary differential equations (Math 315/325/263) and programming experience (COMP 202) or with permission of instructor.
Textbook:
Richard Burden and J. Faires, Numerical Analysis, 9th edition (Not required, course and tutorial notes should be sufficient.)

Grading

Your grade for this course will be based on homework assignments, one midterm and a final exam, weighted as follows:
20% homework + 20% midterm + 60% final exam

Note: if you have a valid reason for a formal deferral of the midterm, you have the option to write a make-up assessment or choose the following grading scheme: 20% homework + 80% final exam.

Homework:
There will be four assignments (each worth 5%) containg both theoretical and computing questions. Any computing language is accepted, though Matlab is highly recommended. **You must submit hard copies of assignments. Late assignments will not be graded. No make-up exams, no extra work.**

Midterm:
Closed book exam.
Date: **October 27, 2016**
Location: TBA

Final Exam:
Date/Location: See exam schedule.

Course Outline

(X.Y) refer to chapter X and section Y in the course textbook.

- **Floating point numbers and error propagation** (1.2)
- **Review of calculus** (1.1)
  Rolle's theorem, intermediate value theorem, Taylor remainder theorem
- **Root finding methods** (2.1-2.4)
  Bisection, fixed point iteration, Newton, error analysis, convergence rate
- **Interpolation** (3.1, 3.3-3.5)
  Lagrange, Chebyshev, Hermite, cubic spline
- **Numerical differentiation and integration** (4.1, 4.3, 4.7)
  Finite difference, midpoint/trapezoidal/Simpson's rule, Gauss quadrature
- **Richardson extrapolation** (4.4) **(if time permits)**
- **Numerical method for ODE** (5.2-5.4, 5.6, 5.10, 11.1)
  Euler, multistep, predictor-corrector, Runge-Kutta, consistency,
  shooting method, finite difference
- **Iterative methods for linear systems (if time permits)**
  Richardson, Jacobi, Gauss-Seidel, SOR, condition number, spectral radius, convergence
- **Numerical method for Poisson's/heat/wave equation (if time permits)**

University Policy

McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures
(see `http://www.mcgill.ca/students/srr/honest/` for more information).

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

Tentative Schedule

	Tuesday	Thursday
Week 1 (Sep 5)	course introduction, floating point numbers, absolute and relative error	error propagation, Rolle's theorem, intermediate value theorem
Week 2 (Sep 12)	Taylor's remainder theorem, Taylor approximation and series, root finding method, convergence order	bisection method, fixed point method
Week 3 (Sep 19)	fixed point method, Newton's method	secant method, system of equations
Week 4 (Sep 26)	interpolation, Lagrange polynomial	Newton's divided difference, **(Assignment 1 Due)**
Week 5 (Oct 3)	error analysis, Runge's phenomenon, optimal interpolation error	Chebyshev polynomial, Hermite interpolation
Week 6 (Oct 10)	splines	numerical differentiation, degree of accuracy
Week 7 (Oct 17)	error through Taylor expansion, numerical integration	degree of accuracy, Gauss quadrature, **(Assignment 2 Due)**
Week 8 (Oct 24)	composite quadratures, initial value problem, explicit/implicit k-step methods	**Midterm October 27**
Week 9 (Oct 31)	local truncation error, consistency, convergence, linear multistep method	zero-stability, A-stability
Week 10 (Nov 7)	predictor-corrector method Runge-Kutta method, system of ODEs	boundary value problem, shooting method with secant method
Week 11 (Nov 14)	shooting method with Newton's method finite difference method	consistency, stability, convergence **(Assignment 3 Due)**
Week 12 (Nov 21)	iterative methods for linear systems: Richardson, Jacobi, Gauss-Seidel, SOR	convergence of iterative methods, spectral radius, convergence rate, convergence of Richardson
Week 13 (Nov 28)	condition number, convergence of Jacobi, convergence of Gauss-Seidel **(Assignment 4 Due)**	Applications course review