**Carleton University**
**Department of Systems and Computer Engineering**
**ECOR 2606 – Numerical Methods**
**WINTER 2019 Course Outline**

## Instructor Information and Office hours

| Section | Instructor | Office | email |
|---|---|---|---|
| **D** | Dr. Baha Uddin Kazi | 3220-VSIM | bahauddinkazi@sce.carleton.ca |
| **E** | Dr. Cristina Ruiz Martin | 3210-VSIM | cristinaruizmartin@sce.carleton.ca |

***Office hours will be posted on CuLearn

## TA Information and Office hours

TAs information and their office hours will be posted on CuLearn

## Course Number and Calendar Description

ECOR 2606 - Numerical Methods

Numerical algorithms and tools for engineering and problem solving. Sources of error and error propagation, solution of systems of linear equations, curve fitting, polynomial interpolation and splines, numerical differentiation and integration, root finding, solution of differential equations. Software tools.

Precludes additional credit for SYSC 2606.

## Prerequisites

MATH 1005 and (ECOR 1606 or SYSC 1005) and (ECOR 1010 or ELEC 1908).

## Course Objectives

The main objectives of the course are:

- to be able to apply numerical methods to solve real-life problems by hand and implementing the numerical methods on a computer
- to be able to use Matlab to produce numerical solutions for the different types of problems

## Learning Outcomes

By the end of this course students should be able to:

- Use numerical algorithms to solve problems related to: Root finding, Optimization, Linear
- Systems, Regression, Interpolation, Integration and Differentiation
- Use built-in functions in Matlab to produce numerical results

- Develop and implement basic Matlab programs to solve problems

**Graduate Attributes (GA's)**

5.3 Tools for design, experimentation, simulation, visualization and analysis (work on wording)

All the learning outcomes of this course aim to prepare students to develop their competence in GA 5.3 (Tools for design, experimentation, simulation, visualization and analysis (work on wording))

**Textbooks (or other resources) if applicable**

- Course material will be posted on the CuLearn
- Recommended Textbook:
  Applied Numerical Methods with MATLAB: for Engineers and Scientists; Steven Chapra; McGraw Hill, Third or Fourth Edition.
- Students may download a copy of Matlab for their personal use at no charge. Please see the instructions on CuLearn

**Evaluation and Grading Scheme**

| **Element** | **Dates** | **Weight** |
|---|---|---|
| Tutorial Labs (6) | See lab schedule on CuLearn. **No deferred lab** | 10% (2% each, up to a maximum of 10%) |
| Lab Quizzes (5) | See lab schedule on CuLearn | 20% (4% each) |
| Midterm Exam (**75min**) | March 2nd (Saturday morning) (Tentative. Will be confirmed on CuLearn) | 20% |
| Final Exam (**3hours**) | During the university's exam period | 50% |

**Breakdown of course requirements:**

1. In order to pass the course, students **must pass the final exam.**
1. If a student misses the midterm and valid documentation is provided, they will write a deferred Midterm Exam. They **must** inform the instructor **no later than three (3)** working days after the midterm work was due (i.e. no later than **March 6th**)
2. Students who miss a lab quiz with valid documentation may write with another section in which there is room. If that is not possible, the weight will be added to the other lab quizzes.
3. There will not be deferred lab tutorials
4. Physicians' notes will only be accepted if they are dated within one day of the test. Any valid documentation must be submitted within three (3) working days.
5. Problem sets will be assigned. They will not be graded but your understanding of the correct solutions will be important for success in the graded components.

**Calculators**: Only approved calculators may be used during tests. The list of approved calculators will be posted. Students whose calculators are not on this list may apply to have them added to it. Any such applications must be made at least five working days prior to a test. Graphing and programmable calculators will not be considered.

There will be 6 labs and 5 lab quizzes. Full lab schedule is posted on CuLearn.

**The final examination is for evaluation purposes only and will not be returned to students**. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

All tests, quizzes and exams are governed by Carleton University examination regulations. https://carleton.ca/ses/examination-regulations/

Section 2.5 of the Academic Calendar applies to all exams and lab quizzes. Students are expected to complete the midterm examination or lab quiz once begun. If the student experiences a significant deterioration of his/her health while the exam/quiz is in progress, it may be possible to appeal to your instructor

**Week-by-Week breakdown**

| Tentative Week | Topic | Chapra ($4^{th}$ Ed) |
|---|---|---|
| Week 1 | Introduction | Ch 1 |
| Week 1-4 | Root Finding<br>- Matlab: the basics, functions, vectors, plotting, fzero, roots<br>- Theory: Bisection, Regula Falsi, Secant, Newton'sMethods | Ch 2,3,5,6 |
| Week 4-5 | Minimization / Maximization<br>- Matlab:fminbnd<br>- Theory: Golden Section Search | Ch 7 |
| Week 6-7 | Systems of Linear Equations (Direct methods)<br>- Matlab: matrices,leftdivision, inv, lu<br>- Theory: Gaussian, Gaussian with partial pivoting, Gauss-Jordan, numerical errors, matrix condition, matrix inverse, LU Factorization | Ch 8, 9, 4, 10, 11, 12 (Gauss-Jordan not covered) |
| Week 7 | Systems of Linear Equations (Iterative methods):<br>- Theory: Gauss-Seidel, Jacobi | Ch12, 13 |
| Week 8 | Regression (Polynomial and General Linear Least Squares)<br>- Matlab:polyfit, polyval, left division, qr<br>- Theory: least squares, QR factorization | Ch 13, 14, 15 |
| Week 9 | Interpolation (Polynomial and Splines)<br>- Matlab:polyfit, interp1, spline, ppval<br>- Theory: Lagrange polynomial, Newton's polynomial, splines | Ch 17, 18 |
| Week 10 | Numerical Integration<br>- Matlab:trapz, quad<br>- Theory: trapezoidal integration, Simpson's rules, Richardson extrapolation (Romberg integration), Gaussian quadrature | Ch 19, 20 |
| Week 11 | Numerical Differentiation | Ch 21 |

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|---|---|---|
| | - Matlab: diff, gradient<br>- Theory: forward, backward, and central difference formulae, Richardson extrapolation | |
| Week 12 | Differential Equations<br>- Matlab: ode45<br>- Theory: Euler's method, Runge-Kutta Methods, Heun's methods | Ch 22 |

## General Regulations

**Attendance:** Students are expected to attend all lectures and lab periods. The University requires students to have a conflict-free timetable. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 1.2, Course Selection and Registration and Section 1.5, Deregistration.*

**Health and Safety:** Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

**Deferred Term Work :** Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 2.6, Deferred Term Work.*

**Appeal of Grades :** The processes for dealing with questions or concerns regarding grades assigned during the term and final grades is described in the *Undergraduate Calendar, Academic Regulations of the University, Section 2.7, Informal Appeal of Grade and Section 2.8, Formal Appeal of Grade.*

**Academic Integrity:** Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: https://carleton.ca/registrar/academic-integrity/. This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

**Plagiarism:** Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

**Academic Accommodation:** You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www.carleton.ca/equity/For an accommodation request, the processes are as follows:

- **Pregnancy obligation**: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for

accommodation is known to exist. For more details see https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

- **Religious obligation**: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf
- **Academic Accommodations for Students with Disabilities**: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult https://carleton.ca/pmc/students/dates-and-deadlines/ for the deadline to request accommodations for the formally-scheduled exam (if applicable).
- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.
- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf