Applied Mathematics 2814G
Numerical Analysis

Undergraduate Course Outline Winter 2019
Department of Applied Mathematics
Western University

Course Description

Introduction to numerical analysis; polynomial interpolation, numerical integration, matrix computations, linear systems, nonlinear equations and optimization, the initial value problem for ODE. Assignments using a computer and the software package, Matlab, are an important component of this course.

Lectures

MWF 8:30 - 9:30 AM, MC-105B

Attendance will be taken. Bring your ID.

Tutorials

Tuesday 8:30 - 9:30 AM, HSB-13

Thursday 9:30 - 10:30 AM, HSB-13

There will also be an extra tutorial for extra help every Thursday from 8:30 - 9:30 AM in HSB-13.

Requirements

Prerequisites: Math 1600A with a minimum mark of 55%

Antirequisites: AM2413 or the former AM2813B

Pre-or Corequisites: Calculus 2302A/B, 2402A/B or 2502A/B

Recommended companion course: CS 2035

Instructor

Prof. Robert Corless
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Web: `http://www.apmaths.uwo.ca/~rcorless/`
Office Hours: TBA

Teaching Assistant

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Textbook

- *Numerical Computing with MATLAB* by Cleve Moler, ISBN: 978-0-898716-60-3:

    - Free PDF available for individual use: www.mathworks.com/moler/chapters.html
    - A physical copy may be purchased (optionally) by joining SIAM as a student member at siam.org and ordering at bookstore.siam.org

Supplementary Material (optional)

- *Fundamentals of Numerical Computation* by Tobin A. Driscoll and Richard J. Braun, ISBN: 978-1-611975-07-9

- *Learning Matlab* by Tobin A. Driscoll, ISBN: 978-0-898716-83-2

- *Matlab Guide (Third Edition)* by D. J. Higham and N. J. Higham, ISBN: 978-0-898715-78-1

- *A Graduate Introduction to Numerical Analysis* by Corless and Fillion (eBook available for free through UWO library)

Recommended Software

Matlab will be used for all labs as well as for the midterm. Instructions on how to obtain a **free** copy of Matlab through the university can be found: https://wts.uwo.ca/sitelicense/matlab/activation.html.

Course Content

The course content is divided in two parts: numerical mathematics and Matlab programming. We will teach them concurrently, but they are listed separately below.

Numerical Mathematics

1. Why floating-point, and not exact arithmetic

2. Review of Taylor polynomials; complex numbers; Horner's method for evaluating polynomials, numerical stability, condition

3. Review of Finite Riemann Sums and the Mean Value Theorem

4. Root finding: Newton's method, secant method, bisection; backward error and conditioning

5. Interpolation and the barycentric forms, backward error and conditioning

6. Numerical Linear Algebra: QR, SVD, LU and GEPP, residual, condition number

7. Marching methods for IVP for ODE: Euler, Implicit Euler, ode45, ode15s, and other methods.

8. Numerical quadrature and numerical differentiation

Computer Programming

1. Floating-point arithmetic, the IEEE standard and the interesting differences to real/complex arithmetic. Binary, Hex, Decimal

2. Data types: floating-point, integer, vector, matrix

3. Assignment (=), testing (==, >, <, >=, <=, ~=, or, &)

4. Warning: floating-point equality, eps, realmin, realmax, float(infinity), 1i, signed zero

5. Loops, indexes into vectors.

6. if-then-elseif-else, for, while, error, break, warning

7. How to debug; naming conventions, indentation, style, comments

8. String manipulation

9. Inline functions, m-files, directories, and path

10. Publish and LaTeX. Why not Word? Why not Syms?

Evaluation

Your grade will consist of:

- 30% Labs, 5% Reading Memos, 30% Midterm Exam, 35% Final Exam.

The midterm exam will be computer-based and assess proficiency in Matlab.

Schedule (tentative)

Lab	Tutorial Dates Held	Date Due
Lab 1A	Jan. 8 & 10	Jan. 17 at 11:59 PM
Lab 1B	Jan. 15 & 17	Jan. 17 at 11:59 PM
Lab 2A	Jan. 22 & 24	Jan. 24 at 11:59 PM
Lab 2B	Jan. 29 & 31	Jan. 31 at 11:59 PM
Lab 3A	Feb. 5 & 7	Feb. 7 at 11:59 PM
Lab 3B	Feb. 12 & 14	Feb. 14 at 11:59 PM
Reading Week	Feb. 18 – Feb. 22	—
Midterm Prep	Feb. 25 & 28	—
Midterm	Mar. 1	—
Last day to drop course	Mar. 7	—
Lab 4A	Mar. 5 & 7	Mar. 7 at 11:59 PM
Lab 4B	Mar. 12 & 14	Mar. 17 at 11:59 PM
Lab 5A	Mar. 19 & 21	Mar. 21 at 11:59 PM
Lab 5B	Mar. 26 & 28	Mar. 31 at 11:59 PM
Final Prep	Apr. 2 & 4	—

Lab Instructions

Each lab is broken into two parts for a total of 100 marks (6% of your final grade for each lab). Part A and part B are each worth 50 marks.

Submission Instructions

Part A

Part A of each lab is generally introductory. Any code written along with any figures should be submitted on OWL. Further submission instructions will be given in the tutorials.

Part B

IMPORTANT! READ THIS CAREFULLY.

Labs are to be done in teams. You will be assigned into groups by the instructor or the T.A.

Each part B of a lab will require a full written report explaining what you did in the lab as well as the results you obtained. You do not need to write anything about what was done in part A of the lab. Because this is an essay course you **will** be graded on code style, writing style, grammar, spelling, etc.

When submitting your part B write up along with the code from part B you will be required to:

- Submit a digital copy of your write up **and** code on OWL (due on the date stated above)
- Submit a printed copy of your write up **and** code in class the following day
- Attach the marking outline that will be provided with the assignment to your printed copy

Grades will be deducted if the above instructions are not followed. If either the digital copy or the printed copy of the assignment is not submitted you will receive a grade of 0. Only one of the

printed or digital copy needs to be submitted before the due date to avoid late penalty.

Reading Memos: Part of each Part A Lab will be a "Reading Memo". You will be graded "Yes/No" if they're there or not; the memo itself will not be judged on quality.

Further instructions will be covered in the tutorials.

Midterm

The midterm for the course will be on **Friday, March 1, 2018** . Details will be posted later.

Late Marks

Late marks for part A labs:

- 20% deducted for up to **one** day late
- 40% deducted for up to **two** days late
- 60% deducted for up to **three** days late
- 100% if not submitted within 3 days

Late marks for part B labs:

- 20% deducted for up to **one** day late
- 40% deducted for up to **two** days late
- 60% deducted for up to **three** days late
- 80% deducted for up to **four** days late
- 100% if not submitted within 4 days

Addendum to all Applied Mathematics Course Outlines

Accessibility Statement: Please contact the course instructor if you require material in an alternative format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

On Academic Ethics for Lab Reports: Collaboration with due credit given is good, taking others' work and claiming it as your own is bad. This isn't a hard concept on the surface.
When collaboration is really good: if you help someone else, or they help you, and it solidifies your understanding or helps you "get it," it's very good. Then you'll be able to demonstrate that understanding on the exams (which you do on your own).
When collaboration is bad: when someone does your work for you, and you learn nothing. This will show up on the exam.

Statement On Academic Offences: Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a scholastic offence, at the following web site: `http://uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf`.

Support Services: Students who are in emotional/mental distress should refer to Mental Health@Western `http://uwo.ca/health/mental_wellbeing/` for a complete list of options about how to obtain help.

Academic Accommodation: If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to your faculty's Dean's Office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from your faculty's Dean's Office immediately. For further information please see: `http://www.sdc.uwo.ca/ssd/academic_accommodation/index.html`.

A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Dean's Office) for visits to Student Health Services.