

## COURSE OUTLINE

### MATH 348: Numerical Methods

#### Instructor(s)

**Lecturer** Boualem Khouider, Professor

**Research Area** Applied Math, Scientific Computing, Computational Fluid Mechanics, Atmospheric Science, and Climate Modelling

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**Office** David Turpin Building A550

#### General Course Information

**Number of Units** 1.5

**Pre-requisites** MATH 110 or MATH 211; and one of MATH 200 and MATH 201, MATH 200 and MATH 204, MATH 202.

**Note** Credit will be granted for only one of MATH 348, CSC 340, CSC 349A.

#### Office Hours and Assistance

**Tuesday** 2:30 pm to 4:30 pm, DTB A550

**Wednesday** 2:30 pm to 4:30 pm, DTB A550

**or** By appointment (send email to book one)

**Math Club** Students in Undergraduate Mathematics and Statistics (SUMS) was founded in 2014 as the reincarnation of a previous undergraduate course union that had been inactive for a few years. Please see <http://www.uvic.ca/science/math-statistics/current-students/undergraduate/sums/index.php> for more information.

#### Learning Objectives

- You'll be introduced to the art and practice of numerical methods and the algorithms used to solve practical science and engineering problems, an area broadly known as scientific computing

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<sup>1</sup>Feel free to send me an email to ask questions at anytime of the day or day of the week but do not expect an immediate answer. In case of emergency please use the phone or contact the department.



- You will learn about the design and performance properties of various methods: convergence, accuracy, and efficiency and their behaviour when implemented in a digital computer
- You will be able to solve fairly complex math problems, on a digital computer and be able to choose the appropriate method for the appropriate problem
- You will become familiar with (some of) the available software and be able to create your own code (in matlab, at least) to solve some hard math problems, that is, problems that are unsolvable by hand!

## Course Material and Online Resources

**Textbook** No textbook is required for this class. However, it is highly recommended that you get a hold of one of the texts below for your own reference (sometimes just to crosscheck and compare with what you get in class).

- *Numerical analysis*, by Richard L. Burden and J. Douglas Faires. Thomson Brooks/Coole, 8th (2005) or later editions.
  - *Numerical methods in scientific computing*, by G. Dahlquist and A. Bjorck, SIAM, 2008.
  - *Accuracy and Stability of Numerical Algorithms*, by Nicholas J. Higham, SIAM, 2002.
  - *Mathematical Modeling*, M.M. Meerschaert, Academic Press, 4th Edition (2013)
  - *Numerical Mathematics and Computing*, W. Cheney and D. Kincaid, Thompson, 2008
- ( **Those in the math finance program**)
- *Numerical methods in finance and economics: A Matlab-based introduction* by Paolo Brandimarte, Wiley Interscience, 2nd Edition, 2006. (**The electronic version of this text is available online—for free via the UVic library.**) I will occasional use examples from this book and all of the above.
  - *Numerical methods in Economics*, by Kenneth L. Judd. The MIT Press, 1998.
  - *Applied computational economics and finance*, by Mario J. Miranda and Paul L. Facker. The MIT Press, 2002

**Class Notes** will posted and regularly updated on the course webpage

**Course webpage** <http://www.math.uvic.ca/courses/2016f/math348/a01/index.html>

**Calculator** If a calculator is allowed in tests and examinations in a course offered by the Department, then the only acceptable calculator is the Sharp EL-510R or the Sharp EL-510RNB. It may be purchased at the UVic Bookstore or elsewhere for about \$12. A calculator is permitted in this course.



## Class Meetings

The class meets 10:30 am - 11:20 am, TWF in Cornett Building B107. The first lecture will be Wednesday Sept. 09, 2016. The course has no tutorials. If you need help with your programming assignment, please come to office hours with your questions. If too many people have difficulties with programming (because you're doing this for the first time), then one of the office hours can be moved in a room with computers (TBA if applicable). **You may remind me to discuss this in class!**

## Specific Topics

- Introduction to Matlab environment (throughout the term)
- Basics of numerical analysis: Computer arithmetics, rounding, conditioning and stability. (2h)
- Linear systems: Gauss elimination, LU factorization, Cholesky's method, Matlab's backslash operation. (6h)
- Interpolation: Lagrange polynomials, Interpolation Error, Other interpolation techniques, Piece-wise interpolation, Interpolation in Matlab. (4h)
- Non-linear equations: Bisection, Newton, Fixed point, Convergence, functions fzero and fsolve of matlab. (3h)
- Optimization: unconstrained and constrained optimization, applications, functions fminunc and fmincon of matlab. (5h)
- Numerical integration: Newton Cotes, Integration errors and convergence, order of accuracy, Composite rules, Gauss quadrature, matlab functions trapz, quad, etc. (3h)
- Monte Carlo Simulations: Pseudo-random numbers, variance reduction techniques, applications, functions rand and randn of matlab, simulating a stochastic birth death process, (4h)
- Ordinary differential equations: Euler, local and global errors, convergence, order of accuracy, Taylor and Runge-Kutta methods, matlab ode solvers: odes45,ode23, etc. (5h)
- Finite difference methods for the heat equation: Consistency, stability, and convergence, Implicit and Crank-Nicholson methods, Iterative methods, Applications. (6h)

## Evaluation and Grading

Your final percentage grade will be computed according to the following scheme.

Homework Assignments	Midterm Exam	Final Exam
Bi-weekly	Tues. Oct. 11	TBA
50%	20%	30%



**Accessibility** Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the Resource Centre for Students with a Disability (RCSD) as soon as possible. The RCSD staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations <http://rcsd.uvic.ca/>. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.

**Grading** Percentage scores will be converted to letter grades according to the university-wide standard table

(Undergraduate: <http://web.uvic.ca/calendar2016-09/undergrad/info/regulations/grading.html#>). (Graduate: <http://web.uvic.ca/calendar2016-09/grad/academic-regulations/grading.html#>).

**Final Examination** Off-schedule final examinations (i.e., deferred examinations) are given only in accordance with the university policy as outlined in the Calendar. If you are unable to write a final examination due to illness, accident or family affliction, please refer to the following webpages for detailed instructions how to proceed: <http://web.uvic.ca/calendar2016-09/undergrad/info/regulations/concessions.html#> Students are **strongly advised not to make plans for travel or employment during the final examination period** as special arrangements will not be made for examinations that conflict with such plans.

**Supplemental Examinations.** The Department of Mathematics and Statistics does not award 'E' grades or offer Supplemental Examinations in any of its courses.

## Policies and Ethics

**Attendance** The university Calendar states 'Students are expected to attend all classes in which they are enrolled.' (see <http://web.uvic.ca/calendar2016-09/undergrad/info/regulations/attendance.html#>). Our courses are conducted on that basis. If you miss an announcement (information concerning midterms, corrections to assignment, etc.) because you did not attend class, you must accept the consequences of not having learned of the change.

**Guidelines on Religious Observances** Where classes or examinations are scheduled on the holy days of a religion, students may notify their instructors, at least two weeks in advance, of their intention to observe the holy day(s) by absenting themselves from classes or examinations. Instructors will provide reasonable opportunities for such students to make up work or missed examinations.

**Missing work** There will be six homework assignments. Only (the best) five of the six will count towards your final mark. If you miss one or more ( $n$ ) homework assignments, with justified reason, they will be waived and the rest:  $\max(6 - n, 5)$  will be used to compute your homework mark. If you miss the midterm then the final will count 50%. No makeup midterm or assignment will be provided.



**Academic Integrity** Academic integrity is intellectual honesty and responsibility for academic work that you submit individual or group work. It involves commitment to the values of honesty, trust, and responsibility. It is expected that students will respect these ethical values in all activities related to learning, teaching, research, and service. Therefore, plagiarism and other acts against academic integrity are serious academic offences.

**The responsibility of the institution**

Instructors and academic units have the responsibility to ensure that standards of academic honesty are met. By doing so, the institution recognizes students for their hard work and assures them that other students do not have an unfair advantage through cheating on essays, exams, and projects.

**The responsibility of the student**

Plagiarism sometimes occurs due to a misunderstanding regarding the rules of academic integrity, but it is the responsibility of the student to know them. If you are unsure about the standards for citations or for referencing your sources, ask your instructor. Depending on the severity of the case, penalties include a warning, a failing grade, a record on the students transcript, or a suspension.

It is your responsibility to understand the University's policy on academic integrity:

<http://web.uvic.ca/calendar2016-09/undergrad/info/regulations/academic-integrity.html#>

## How to Succeed in This Course

Read the textbook before and after class. Do homework diligently. Ask for help when stuck. Participate in class. Make sure you connect the theory learned in class to homework and especially to programming questions.



## Course Schedule (Dates are approximate)

Week of	Lecture
5/9/16	Introduction to N.A.
12/9/16	Linear Systems
19/9/16	Linear Systems (Last day for adding courses that begin in the first term: 23/9/16 )
26/9/16	Nonlinear equations (Last day for paying first term fees without penalty)
3/10/16	Numerical Integration
10/10/16	Monte Carlo Simulations (Thanksgiving, no class: 10/10/16)
	<b>Midterm Exam: Tues. Oct. 11</b>
17/10/16	Monte Carlo Simulations
24/10/16	Optimization (Last day for withdrawing from first-term courses without penalty of failure: 31/10/16)
31/10/16	Optimization
7/11/16	Applications, (Reading Break, no class (Wed-Fri))
14/11/16	Ordinary Differential Equations
21/11/16	Partial Differential Equations
28/11/16	Applications (ODEs and PDEs) (Last day of classes: 2/12/16)
5/12/16	<b>Exam Period begins: 5/12/16</b>
12/12/16	<b>Exam Period</b>
19/12/16	<b>Exam Period ends: 19/12/16</b>

