MATH 3MB3 - Introduction to Mathematical Modelling

Fall 2019

Instructor:
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- When e-mailing either to the instructor or a TA about the course, please include *"3MB3"* in the subject line and your MacID in the body of the e-mail.
- The TAs will be running labs, marking homework, and assisting with projects. When e-mailing, please allow at least one full business day for responses. Please note also that the **TAs might not respond to emails sent less than 24 hours before any assessment due date (exam/homework/project).** The primary time to get help is during lab but, time permitting, the TAs may be available for extra help outside of that hour.

Course webpage

on Avenue to Learn (A2L): Math 3MB3.

Class meetings

- **Lectures: Mo, We 14:30-15:20, Fr 16:30-17:20 in T34 103**
  - Lecture periods may be used interchangeably, for computer work, lectures, or demonstrations. You may sometimes be expected to bring a laptop or tablet to class; if this is going to be a problem, please contact the instructor as soon as possible to make arrangements. You may want to install free/open-source software on your computer, following instructions to be provided in lab.
  - Lecture periods at the end of the semester will be used for project work and presentations.
- **Labs: Tu 12:30-13:20** (L01),**Th 10:30-11:20** (L02), **Th 12:30-13:20** (L03) **in KTH B121**
  - Labs start on **Tuesday September 10th** (second week of class). All required material covered in labs will be posted online (i.e., attendance is not mandatory, but you will be responsible for all material covered). Labs will be used for a combination of computational troubleshooting; computational and analytical exercises; review and clarification of lecture material; and discussion/review of assignments.

Course description

Objective

To learn to apply mathematical tools to solve open-ended, real-world problems, to understand the benefits and limitations of mathematical modelling, and to critically assess the predictions based on mathematical models, as well as to stimulate interest in studying more advanced topics (e.g. numerical analysis, differential equations, probability and statistics, and optimization.)

- The course will focus on modelling of complex systems; and will cover deterministic discrete-time, deterministic continuous-time (ordinary differential equation), and stochastic models.

- The course will cover computational methods for graphical displays of data, numerical solutions of various dynamical systems, and simulation modelling.

A **tentative** breakdown of the topics to be covered in class can be found on the course webpage.

Goals for students learning

- The course will involve creative and empirical model construction. At the completion of the course, given real-world scenarios, students should have developed the ability to identify a problem, make appropriate assumptions, propose a model, test the assumptions, refine the model if necessary, fit the model to data if appropriate, analyze the underlying mathematical structure of the model in order to appraise any sensitivity of the conclusions to the assumptions and model construction.
- Students will learn model analysis. At the completion of the course, given a model, students should have the ability to work backwards to uncover implicit assumptions, assess critically how well the assumptions reflect the scenario at hand, and estimate the sensitivity of predictions to modifications of the assumptions.
- Students will participate in a group project. At the completion of the course, students should have developed/enhanced their research & scientific communication skills.

Textbooks

Reccomended:

A. Sayama, Hiroki. *Introduction to the Modeling and Analysis of Complex Systems.* Published by Open SUNY Textbooks, Milne Library, State University of New York at Geneseo, 2015. http://textbooks.opensuny.org/introduction-to-the-modeling-and-analysis-of-complex-systems/

B. Turner, Peter R., et al. *Applied Scientific Computing: With Python.* Springer International Publishing Springer Nature, 2018. (available in electronic format at the McMaster Library)

Optional:

C. Langtangen, Hans Petter. *A Primer on Scientific Programming with Python.* 5th edition, Springer Berlin Heidelberg, 2016. (available in electronic format at the McMaster Library)

Software

We will be using Python and Jupyter notebooks for the computational aspects of this course. Lab hours (see above) are reserved for students in this course and you have priority over students not registered in this course or the lab section during that time. I hope that it will be possible for students to bring (or share) a laptop for work during class sessions. Installing Python and Jupyter notebooks on your own computer is optional, but encouraged - instructions will be provided in lab.

Course work

1. Assignments (20%)

- There will be **five homework assignments**, which are mandatory and count towards 20% of your course grade. The due dates for these assignments will be posted on the course webpage. Assignments are to be submitted to the appropriate "Assignment" folder on Avenue before 11:59 PM on the day they are due. Submit a single Jupyter notebook document (.ipynb) containing your text and code. A sample homework assignment in acceptable format will be made available on the course webpage under the "Sample Homework".

- There will be a 10% per day late penalty. MSAF can be used for **only one** homework assignment during the term, and in that case the weight of the missed assignment will be redistributed to the other homework assignments.
- While **collaborative work** on the assignments is allowed and generally beneficial, **each student has to write up the solutions for the assigned problems on their own and in their own words. If you work with others, you must clearly indicate on your write-up who you worked with.** Copying with minor changes (e.g. with symbols changed, or with slightly different wording) from solutions prepared by another person, publication, or website, in whatever format, will be dealt with as an act of plagiarism.

2. Group projects (35%)

You will be invited to form groups of four to six students, **preferably within your lab section**. Each group will selects a topic from a list of project topics that will appear on the course website, or request approval for an alternative topic. You will study this topic and write a project proposal and report about it in writing (individually) and orally (as a group, in class). **Detailed information about project expectations will be provided during the lectures.** Due to the fact that a large number of lectures are dedicated to working on the group project, attendance may be taken during only those classes. Out of respect to each member of your group, it is important that you attend the sessions and actively participate in the research and writing of the project. You will receive a mark proportional to your individual contribution to the project, and failing to participate in a project will result in the grade zero. Projects that are not submitted/presented on their due date will also be graded as zero, unless proper documentation is supplied.

Your proposals (initial and final) should include the following elements:

1. A question about the natural or social world that includes *no math*.
2. Background about that question.
3. State variables.
4. A description of the assumptions and parameters (including units).
5. Model equations for addressing the question.
6. A proposed analysis for how you would use this model to address your question.

A sample proposal will be made available on the course webpage under the "Sample Proposal".

3. Course participation (10%)

Occasionally throughout the semester, you will be asked to write either the instructor or your TA an email (a few sentences to a paragraph) on a particular topic (subject: *3MB3 participation*). The purpose of these emails is for us to be able to assess your depth of understanding of non-technical material. This will allow us to give you feedback and will hopefully make the preparation of your final report at the end of the term less stressful. If you do not come to lecture you will not hear about these participatory emails. If you do not send these emails you will receive a low participation mark. You can also enhance your participation mark by engaging with in-class exercises and coming to office hours.

Exams

There will be **one mid-term exam**, tentatively scheduled for Wednesday October 23rd during class time (location to be announced) and **one cumulative final exam** during the December exam session. The exact time and location of the exams will be announced in class and posted on the course webpage.

Evaluation and Grading

The formula of the course grade is as follows:

Homework Assignments (five)	20%
Participation	10%
Group Project	35%
Mid-term Exam	15%
Final Exam (December)	20%
Total	100%

I reserve the right to change the weight of any portion of this marking scheme. If other formulas are to be considered, your final grade will not be less than the result of the scheme given above.

Please note! Once the final exam is written, the final grade cannot be adjusted to take into account any special situation.

MSAF

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar

"Requests for Relief for Missed Academic Term Work".

In most cases, missed work or tests will be addressed by reweighing the remaining work or tests. If you must miss a lecture, it is your responsibility to find out what was covered. The best way to do this is to borrow a classmate's notes, read them over, and then ask your instructor if there is something that you do not understand.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.
Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty refer to the *Academic Integrity Policy*, located at http://www.mcmaster.ca/academicintegrity/

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not ones own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

On-line Elements

In this course we will be using e-mail, Avenue to Learn (A2L), and the Jupyter notebook platform hosted at mcmaster.ca. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Academic Accommodation of Students with Disabilities

Students who require academic accommodation must contact *Student Accessibility Services (SAS)* to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. *Student Accessibility Services* can be contacted by phone 905-525-9140, ext. 28652 or e-mail `sas@mcmaster.ca`. For further information, consult McMaster University's policy for *Academic Accommodation of Students with Disabilities*.

Academic Accommodation for Religious, Indigenous and Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the *RISO policy*. Students requiring a RISO accommodation should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Disclaimer

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc). If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites such as McMaster Daily News and/or A2L during the term and to note any changes.