WILFRID LAURIER UNIVERSITY

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Course Syllabus

MA680: Seminar in Mathematical Modelling for Science and Finance

Department of Mathematics, Master of Science Program, Faculty of Science, Waterloo Campus

Fall | 2017

Instructor Information

Roderick Melnik | LH-3075
Contact Information: tel. 3662, email: rmelnik@wlu.ca
Weekly Office Hours**:** Tuesday, Thursday 14:30 - 15:30 or By Appointment

Course Information

Calendar description : This seminar course is designed to develop the capacity to abstract salient features of problems in financial mathematics and the scientific disciplines, and to develop, analyze, and interpret models. Problems from financial mathematics and science, using undergraduate mathematics in modelling and analysis, are studied in detail. Commonality of mathematical methods and structures across disciplines is emphasized. Students work individually and in groups, and produce both written and oral reports on their projects.

Pre-requisites : This course is for students with an undergraduate degree in applied mathematics, science, mathematics, finance, or engineering who are registered in the MSc program in Mathematics.

Course location, meeting times and days: Classroom LH-3058, Thursday 11:30 - 12:50, every week. Every even week on Tuesday is reserved for the projects (11:30 - 12:50, LH3066) as students in this class will be using computer labs. Lectures or project consultations will be given every odd week on Tuesday (11:30 - 12:50).

Course Overview and Approach

Course form: Lectures and a semester project.

Course outline: The course consists of lectures and a mathematical modelling project to be completed during the semester and handed at the beginning of December. During the Fall term you will be introduced to a selection of the following topics:

- Basic concepts of mathematical modeling and computational science. The power of abstraction in real-world applications. Historic notes.
- The process of modelling. Classification of mathematical models and their validation. Modelling methods.
- Scaling of models and basic dimensional analysis.

- Differential and variational formulations of mathematical models in science and finance. Variational formulation of two-point boundary value problems. The Rayleigh-Ritz, collocation, and Galerkin methodologies.
- Numerical methodologies for elliptic equations. Energy norm estimates and adaptive error control.
- Stochastic models and their applications in finance and science.
- Variational formulations and energy estimates for parabolic equations. Financial applications. Semi-discrete and fully discrete Galerkin approximations.
- Conservation laws. Characteristic directions and hyperbolic systems. First and second order hyperbolic equations and numerical methodologies for their solution.
- Spectral methodologies, finite volume and boundary element methods.
- Convection-diffusion models and applications in science.
- Ill-posed problems in science and finance and methodologies for their solution.
- Developing your modelling skills via project-based tasks.

Course Learning Outcomes

After studying this course, you should be able to:

- understand basic definitions and terminology associated with mathematical modelling, the methodology of abstraction in real-life applications, classification and validation of mathematical models;
- recognize the importance and value of the process of mathematical modelling on a diverse variety of disciplines;
- recognize and appreciate the connections between theory and applications in the process of mathematical modelling;
- deal with differential and variational formulations of mathematical models and their applications;
- solve PDE-based mathematical models with numerical methodologies, including the finite difference method and variational methodologies;
- develop modelling skills via project-based tasks;
- formulate mathematical models, both deterministic and stochastic, for a variety of examples in studying discipline-specific tasks, in particular for science and finance applications;
- understand the importance of problems with incomplete data and ill-posed mathematical models.

Course Tools and Learning Materials

All necessary handouts will be given to you during the course when applicable. Some information about the course may be posted to the course website at this link. There are no required textbooks in this course. However, there is a wealth of materials for this course and you can find a number of texts that may be useful for the course and for your own future work in mathematical modelling for your specific applications. Some of them will be listed on the course website mentioned above and will be put on a limited-term loan in the University library.

There are also some software links that you may find useful. If your project requires computational tools, Matlab is recommended. However, the use of other tools that you may find appropriate (such as Maple or C++) is in no way restricted. For those students unfamiliar with Matlab, introductory lectures

and/or appropriate materials may be given in the class or posted to the course website. Although the use of additional literature is not required for this course, it is highly encouraged.

Student Evaluation

The assessment in this course will consist of individual mathematical modelling projects and the final open-book examination (3 hours). During your examination calculators, including programmable ones, are permitted. Your own hand-written lecture notes and one textbook of your choice are allowed. The final mark will be converted to a letter grade in accordance with the conversion table given in the University Calendar.

Assessment	**Weighting**	**Due Date**
Math modelling projects	40%	December 7
Final Exam	60%	December 14
Total	**100%**	

In the event of a question regarding the exam mark or the final grade, it is the responsibility of the student to retain and present graded materials which are returned for student possession during the term. Students have one week from the day marked material is returned in class to appeal their grade. No marks will be changed after that time.

Policy statement

Your attendance and promptness are quite important for this class.

- For general University rules see the Laurier Calendar (highlights are given in the end of this statement).
- You are encouraged to collaborate on different aspects of this course with your fellow students, excluding the final examination.
- In addition to the final examination, you will have a semester project during this term. Additional guidelines for preparing your projects will be given to you in the class.
- Note that during your final exam your skills in solving problems such as those appearing in the class are essential. You have to attempt all tasks/subtasks given in the class and to seek understanding and practical applicability of the concepts discussed in the class.

Students are expected to be aware of and abide by all University regulations and policies, as outlined in the current Academic Calendar. In particular,

1. **Final Examinations**
Students are strongly urged not to make any commitments (i.e., vacation) during the examination period, **December 9-22, 2017 (including Sundays).** Every student registered in a course is required to be available during the examination period of the term in which the course is offered. For additional details, see the *Master's Examinations and Course Requirements*.

2. **Special Needs**
Students with disabilities or special needs are advised to contact Laurier's Accessible Learning Centre for information regarding its services and resources. Students are encouraged to review the *Graduate Academic Calendar* for information regarding all services available on campus.

3. **Academic Integrity/Misconduct** (cheating, plagiarism)
The University has a defined policy with respect to Academic and Research Misconduct; penalties are severe and enforced at all times. You are responsible for familiarizing yourself with the academic misconduct policy and penalty guidelines, and are cautioned that, in addition to failure in a course, students may be suspended or expelled from the University for academic misconduct, and the offence may appear on their transcripts. The relevant policy can be found at Laurier's academic integrity website along with resources to educate and support you in upholding a culture of integrity; see https://students.wlu.ca/academics/academic-integrity/index.html. **Ignorance of Laurier's academic misconduct policy is not a defence**.

Academic Misconduct includes transmission or reception of information, or possession of unauthorized information, during laboratories, quizzes, tests, or examinations. Academic Misconduct also includes plagiarism. Wilfrid Laurier University uses software that can check for plagiarism, and students may be required to submit their written work in electronic form for a plagiarism check. The *Student Code of Conduct and Discipline* and the procedures for investigating and determining appropriate disciplinary measures for breaches of this *Code* are given in the Academic Calendar.

4. **Classroom Use of Electronic Devices**
The use of electronic devices in the classroom is governed by WLU Policy 9.3: *Policy on the Classroom Use of Electronic Devices*. Details of this Policy and the consequences of breaches are stated in the Academic Calendar.

Mobile devices such as laptops and tablets may be used in class only for educational (learning) purposes directly related to the course. At times, the instructor may explicitly permit students to use a mobile device to complete an activity or task, at other times, the instructor may ask students to close laptops and turn off tablets in order to focus attention on other course-related tasks. Students who fail to comply may be asked to stow their devices at the front of the classroom, or to leave the classroom.

Course Drop Dates Fall 2017

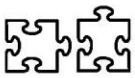
September 13: Last day to drop fall term course(s) with no tuition charge but remain registered (students must remain registered in at least one course) (part-time MBA students only).

September 20: Last day to drop fall term course(s) (part-time MBA students and part-time masters level seminary students) or withdraw from the university (all graduate students) at 10% tuition charge.

November 8: Last day for withdrawing without failure from fall term courses or from the graduate program and for possible tuition adjustment (tuition charge assessed at 55%).

FOOT PATROL 519.886.3668 (FOOT)

Foot Patrol is a volunteer operated safe walk-home service, available daily during evening hours. Teams of two radio-dispatched volunteers are available on request to escort students to and from campus as well as to off-campus destinations. Foot Patrol operates both a walk and van service, and can be found in the office on the ground floor of the Fred Nichols Campus Centre.



PEER CONNECT 1.866.281.7337 (PEER)

Peer Connect is a committee that addresses mental health by promoting a balanced lifestyle for all students. We promote a confidential phone service run by students for students as a resource for any information and support. We run campaigns of mental health, stress relief and healthy body care. We provide programming such as access to athletic equipment, movies, board games and volunteers through booking to dons, icebreakers, campus clubs and campus committees.

EMERGENCY **RESPONSE** TEAM 519.885.3333

The Emergency Response Team provides on-call medical assistance to students on campus. ERT operates Monday through Thursday 3pm-3am and Friday to Sunday 24 hours. ERT can also be booked for on site event support be filling out the online booking request form at ert.yourstudentsunion.ca. Operating on the Waterloo campus only.

STUDENT RIGHTS ADVISORY COMMITTEE studentrights@mylaurier.ca

The Student Rights Advisory Committee exists to provide you with information about your rights when it comes to landlord-tenant issues or academic appeals. While in no way legal representation, it can help to inform you about your options in order to make difficult situations easier to navigate.

FOOD BANK foodbank.yourstudentsunion.ca

Food Bank provides food parcels in order to cater to the nutritional and dietary needs of students. All students are eligible to use this service, regardless of circumstance or financial situation. Request a package at foodbank.yourstudentsunion.ca. Food Bank also carries out various initiatives throughout and during the year such as the weekly on-campus Farmers' Market and monthly Pancake Tuesdays.

For more Information visit www.yourstudentsunion.ca