Math 4060U: Industrial Mathematics

Winter 2012, T, 2:10-3:30 pm, F, 3:40-5:00 pm, ERC1054

Instructor: Dr. C. Sean Bohun.
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Office Hours: TBA or by appointment.
Text: Practical Applied Mathematics: modelling, analysis, approximation by Sam Howison, Cambridge University Press, 2005.
Title: MATH 4060U Industrial Mathematics (3), Section 001.
Description: A case-studies approach is taken to the mathematical modelling of industrial problems and other physical problems that are relevant for industrial applications. Potential topics include: lubrication theory and slow viscous flow phenomena, elasticity, plasticity, crack propagation, chemical reactors and chemical kinetics, heat transfer, materials science modelling, stability theory and vibrations of machinery, semiconductor device modelling, electromagnetics and inverse problems, optimal design. For each topic covered, the modelling process of a specific example is followed from problem formulation to solution. Discrete, continuous, deterministic and stochastic models are used, as is a variety of solution techniques, both analytical and numerical. Both theoretical and practical issues will be considered.
Prerequisite: MATH 3050U, and at least one other 3000-level MATH course.

Examination: Term work will consist of collected homework, **1** midterm, **1** ten minute in-class presentation, **1** final project report and a final exam.

Homework	20%	Due at the start of the following lecture
Midterm	20%	February 17
Class presentation	10%	Week of April 10-13
Final project	20%	Due April 13
Final	30%	TBA

Homework: A few homework problems will be assigned each class. Be sure to do these problems before the next class since some solutions will be collected.

Class Presentation: The last two days of lectures will consist of 10 minute presentations where each student summarizes their chosen final project. Presentations will be produced using Beamer with the LaTeX environment. An example presentation with the LaTeX source code has been provided. Students are assessed not only on the presentation that they give, but also on their participation with the other student presenters.

Projects: Chapters 4, 5, 6, 11, 14, 15, 19, and 21 from the book are case studies. Each student has to choose a project motivated by a problem described in one of these chapters. All projects will be chosen with the advice and consent of the instructor. Although the exact formulation of the project can change during the term, the general area should be chosen by ***January 24***. Some of the classes will be devoted to partial discussion of the projects emphasizing the techniques are are currently being studied. Every student has to prepare a paper, produced in LaTeX, of no more than 8 pages based on the project to be submitted on the last class, ***April 13***.

Grading Policy: The final grades will be assigned as follows:

A+	90% - 100%	B−	70% - 72%
A	85% - 89%	C+	67% - 69%
A−	80% - 84%	C	60% - 66%
B+	77% - 79%	D	50% - 59%
B	73% - 76%	F	49% and below

Academic Honesty: Except for exams and tests, it is assumed that you can discuss problems and assignments amongst yourselves and with tutors and the professor, so long as what you turn in is your own work. In other words, the discussions are part of the learning process; once you learn how to approach a problem, you are expected to solve it yourself, write up your own submission, and that is what you turn in. It is dishonest to turn in as your own any work which has been copied from the work of someone else.
It is expected that each student enrolled at UOIT will become familiar with this policy and appreciate that academic dishonesty of any form will not be tolerated at UOIT. You are encouraged to carefully read the material in this section and to seek clarification from the appropriate Academic Advisor if necessary. Acts of academic dishonesty include, but are not limited to:

> Cheating: Copying answers to exam/quiz questions from another student's exam/quiz paper; copying an out-of-class assignment from another person and submitting it as part of an academic assignment.
>
> Facilitating academic dishonesty: Helping or attempting to help another to commit an act of academic dishonesty.
>
> Plagiarism: Taking and passing off as one's own the ideas or words of another in any academic assignment.

A student charged with academic misconduct may face academic/or disciplinary sanctions. Read the University Policy on Academic Honesty which is located in Section 5.15 of the UOIT academic calendar `http://www.uoit.ca/calendar`

Term Work: The normal policy in the Faculty of Science for missed term work (tests and assignments) is to re-weight the remaining work to account for the missing grade. There are no make-up exams. If you miss a Science term test or major assignment due to illness or a death in the family you must obtain the appropriate documentation (UOIT Medical Certificate, Death Certificate), and submit it to the Science Academic Advisor within 5 days of missing the test or assignment. If you cannot write a test for any other reason, you must discuss this with the Science Academic Advisor and the instructor of the course at least 2 days before you are scheduled to write it. Exceptions to this rule include Varsity Athletics and test conflicts which have different deadlines. If you miss any exam for an invalid reason, you will receive zero for the exam.

IMPORTANT: It is possible that unforeseen circumstances may cause me to alter some of the information in this document. Any such alterations will be announced in class and followed up with a WebCT email message to the students of the class. If you miss any announcement because of inattention or absence from class, then you must accept the consequences of missing it.

Course Schedule

Date	Section	Material	Homework
Jan. 10	1.3	Principles of modelling	p12 #1, p13 #2
Jan. 13	1.4	Conservation laws	p13 #3, #4
	2.2	Units and dimension	p21 #2, p23 #5, p25 #10, p26 #12
	2.3	Electric fields and electrostatics	p21 #1, p22 #4
Jan. 17	3.1	Nondimensionalisation and dimensional parameters	p42 #1, #2
Jan. 20	3.2	The Navier-Stokes equations and Reynolds numbers	p44 #5
	3.3	Buckingham's Pi-theorem	p48 #13
Jan. 24	Case studies	Hair modelling and cable laying	
Jan. 27	Case studies	The thermistor I	
		Electrostatic painting I	
Jan. 31	7.1	First-order quasilinear PDEs	p97 #1
	7.2	Poisson processes	p98 #3, #4
Feb. 3	7.3	Shocks	p100 #5, #6, p101 #7
	7.4	Charpit's method	p102 #8, #10
Feb. 7	7.5	Second-order linear equations in two variables	p102 #11
Feb. 10	Case studies	Traffic modelling	
Feb. 14	9.1-9.3	The delta and Heaviside functions	p134 #1, #2
Feb. 17	**EXAM**	Midterm	
Feb. 21	**NO CLASS**	Reading Break	
Feb. 24	**NO CLASS**	Reading Break	
Feb. 28	9.4-9.5	Balancing singularities	p128 #9
Mar. 2	9.6	Green's functions	p134 #3, p136 #6
Mar. 6	10.1-10.5	Theory of distributions	p149 #3, p150 #6, p151 #7
Mar. 9	10.6	Extensions of the theory of distributions	p153 #15, p154 #16
Mar. 13	Case studies	The pantograph	
Mar. 16	12.1-12.3	Asymptotic expansions	
Mar. 20	13.1-13.3	Regular perturbation expansions	p195 #2
Mar. 23	13.4-13.6	Linear stability	p197 #5
Mar. 27	Case studies	Electrostatic painting II	
		Piano tuning	
Mar. 30	16.1-16.3	Boundary layers: examples from ODEs	p230 #2, p231 #4
Apr. 1	16.4-16.5	Boundary layers: examples from PDEs	p232 #6, p232 #8
Apr. 6	**NO CLASS**	Good Friday	
Apr. 10	Case studies	**Presentations**	
Apr. 13	Case studies	**Presentations**	