Syllabus for Math 3650, Differential Equations II

Sean Fitzpatrick
Department of Mathematics and Computer Science
Faculty of Arts and Sciences
University of Lethbridge
sean.fitzpatrick@uleth.ca

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Oki, and welcome to the University of Lethbridge. Our University's Blackfoot name is Iniskim, meaning Sacred Buffalo Stone. The University of Lethbridge acknowledges and deeply appreciates the Siksikaitsitapii peoples' connection to their traditional territory. We, as people living and benefiting from Blackfoot Confederacy traditional territory, honour the traditions of people who have cared for this land since time immemorial. We recognize the diverse population of Indigenous Peoples who attend the University of Lethbridge and the contributions these Indigenous Peoples have made in shaping and strengthening the University community in the past, present, and in the future.

1 Essential Information

We begin with a list of the essential (and mandatory) details for the course:

Course Instructor

Dr. Sean Fitzpatrick
Contact: via email (sean.fitzpatrick@uleth.ca)
Office: UH C540
Office hours:

- Monday: 1 – 3 p.m.
- Wednesday: 10 a.m. – 12 p.m. and 1 – 3 p.m.
- Friday: 10 a.m. – 12 p.m.

Any exceptions to this schedule will be announced on Moodle.

Course Website:

via Moodle (moodle.uleth.ca)

Course Textbook

The two primary texts for the course will be *An Introduction to Laplace Transforms and Fourier Series* by Phil Dyke, 2nd ed. and *An Introduction to Partial Differential Equations*, by Peter J. Olver. Both books are published by Springer, and both can be accessed for free through SpringerLink as long as you're on campus, using our library's subscription.

A list of additional resources will be provided on Moodle.

Class Meetings

Tuesday & Thursday, 3:00 - 4:15 p.m. in Science Commons SA 7212
First day of class is Thursday, January 8th

Course Description (As per the Academic Calendar.)

> Adjoints. Oscillation theory. Matrix methods. Matrix exponential functions. Sturm-Liouville theory. Orthonormal systems and Fourier series. Eigenfunction expansions. Laplace, Fourier and Mellin transforms. Convolutions. Convergence theory. Plancherel and Parseval formulae. Distributions. Solving PDEs using integral transforms. Fundamental solutions. Separation of variables. Heat, wave and Poisson equations. Harmonic functions. Prerequisite(s): Mathematics 3600 Corequisite(s): One of Mathematics 2575 or Mathematics 2580

The list of topics here is overly ambitious. We will cover most of the main themes here, but may vary some of the details. The main themes:

- Integral transforms (Laplace and Fourier)
- Fourier series and expansions in terms of other orthogonal families of functions
- Partial differential equations: important equations from Physics, methods for solution, and some general theory
- Boundary value problems

Our (rough) plan for the topics schedule is as follows:

- Weeks 1-2: Laplace transforms, using Dyke, Chapters 1-3.
- Weeks 3-4: Fourier series, usind Dyke, Chapter 4 and Olver, Chpater 3. I will also cover some content on general theory, involving other "orthogonal families of functions".
- Week 5: accounting for the fact that the above topics will probably need more than 4 weeks.
- Weeks 6-8: Partial differential equations. We'll go over some of the important examples, and methods for solving them. For this, we'll use Dyke, Chapter 5, and Olver, Chapters 1, 2, and 4.
- Week 9: Distribution theory, using Olver, Chapter 6, and notes I'll provide.
- Week 10: Fourier transforms, using Dyke, Chapter 6, and Olver, Chapter 7.
- Weeks 11-12: Boundary value problems and Sturm-Liouville theory, using Olver Chapter 9, and additional resources as needed.

2 Assessment and grading

We will have just two types of assessment:

1. *Assignments.*

   We will have six written assignments. These will be problem sets consisting of exercises intended to help you learn the material.

   Assignments can be done alone or in groups. I will set aside time in class for you to work on the assignments, with the assumption that you will need to spend time out of class to get them done.

   I expect that assignments you submit will be "good copies". Hand-written is fine, but you should provide sufficient written explanation, avoid excessive crossing out, messy work, etc.. Things like coffee stains should be avoided (unless you are using the LaTeX coffee stains package).

   Once per assignment, if you completely miss the mark on solving a problem, you can make a second attempt by presenting the solution in my office. Corrections to group assignments should be presented as a group.

2. *Projects.*

   You will also need to complete three projects. Projects should be done in groups of 5-6 students. The differences between a project and an assignment are as follows:

   - On an assignment, I set the problems. On a project, you decide what the content will be.
   - A completed assignment is just a set of solutions to exercises. A project should have a *narrative*: explain what te topic is, how it relates to the course material, and why it's an interesting topic to consider.

     Your work should be more expository/explanatory, although I would still like to see some solved problems done as examples.
   - A project must have references. (You can use any of the textbooks I've suggested as references.)

   For each project, you will be assessed on two items:

   (a) A written submission. This should be typed, and about 5-6 pages in length. (If you have a lot of figures or some other reason you need more room, it's fine to add a few more pages.)

   (b) A presentation. Presentations should be 15-20 minutes in length. It isn't necessary for every member of the group to speak during the presentation, but you should find a way to ensure that all group members have a way to contribute.

   Presentations should be done in class, but if your group is uncomfortable with this, or if we're finding it difficult to find time for everyone, we can consider alternatives, like recording a video to share with the class.

   The project score will be 60% written, and 40% oral.

   Project topics: there is a lot of interesting mathematics related to the material in this course! We won't have time to cover most of it. I am happy to make suggestions if your group isn't sure what to do. You might start by looking at the table of contents in some of the books I've suggested for topics that (a) look interesting, and (b) aren't among those listed in the course description above.

   Physics students might be interested in explaining the physical origins of some of the differential equations we study, or digging deeping into how tools like the Fourier transform tie into subjects like quantum mechanics.

   If you want to take a break from the technical stuff, there is also a lot of interesting history here! For example, it wasn't until the work of Fourier that mathemticians were forced to reckon with what we really mean by the word "function".

   Whatever you're interested in doing, I will be happy to discuss ideas and resources with your group.

Your overall grade will be 50% assignments, and 50% projects. Conversion from percentage grades to letter grades will be as follows:

Table 2.1 Conversion of percentage scores to letter grades in Math 3650

A+	96-100
A	90-95
A-	87-89
B+	84-86
B	78-83
B-	75-77
C+	71-74
C	65-70
C-	60-64
D+	56-59
D	50-55
F	0-49

3 Course policies (an FAQ)

This section deals with questions about accommodations, missed tests, and other exceptional (yet common) cases.

1. *This week is super busy and I don't think I can finish the homework on time. Can I have an extension?*

   Yes.

2. *What happens if I get sick?*

   First and foremost, do not come to class and make everyone else sick! I'll do my best to be accommodating of any illness that interrupts your studies. There is no need to provide details of the illness. If you miss a week or more of work, please get in touch to make a plan for catching up. One of the biggest challenges in math is that once you fall behind, it's difficult to catch up on your own.

   If you're staying home to avoid spreading illness to others (thank you!), but well enough to attend class, I'll try to provide you with a video link via Teams or Zoom.

3. *What exactly does academic honesty mean?*

   In short, that any work you represent as your own, is your own. Much of your work can be done in groups, but not all of it. I will assume that you have access to a calculator, including online software that gives you step-by-step solutions.

   Use of these tools while practicing is acceptable, but take care that you are not overly reliant on them. What is not acceptable is having someone else do your work for you. This includes tutors, classmates, friends, family members, online "homework help" sites. If you submit work that somebody else did for you, you are committing an academic offence.

   If you have someone else write a test or exam for you, not only have you committed an academic offense, but the person impersonating you is at risk of criminal fraud charges under Canadian law.

   Penalties for academic dishonesty are outlined in the New student code of conduct (`www.ulethbridge.ca/policy/resources/new-student-code-conduct-policy`). Depending on the severity of the offence, penalties for a first offence can range from a grade of zero on an assessment, to an F in the course. Academic offences are also reported to the Dean of Arts & Sciences. They keep a record of each offence, and students with multiple offences can be subject to supplementary discipline.

4. *Do "acceptable online tools" include the use of AI?*

   If you are just doing extra practice and nobody better is around to talk to, you can use AI to check your work. If you use AI to do your homework (for marks) you're committing an academic offence.

   Do I have any way of finding out if you use AI to complete your online homework? Probably not. But the overall weight of your homework is quite small, and the point of the homework is to prepare for the tests.

   Existing cognitive research (`www.media.mit.edu/publications/your-brain-on-chatgpt/`) suggests that large language models are very good at tricking you into thinking you're engaging with content, while in fact you end up retaining about as much as if you had done nothing at all.

   The point of everything you do in a university class is the process, not the outcome. The process is where learning takes place. If you hand it off to someone (or something) else, you're depriving yourself of that learning opportunity.

5. *Does that mean I'm not allowed to get help with my homework?*

   Not at all! Working with classmates on your homework is a great way to learn. But keep in mind that your course instructors will be available for help, free of charge. (OK, maybe not free of charge, but you've already paid for it with your tuition.) We will be responding on the discussion forum regularly, There will be time to ask questions in every class, and there will be online office hours. The Student Success Centre will also be running free help sessions (details TBA).

Some of you may still decide to pay for tutoring, and that's fine. But you have a duty to disclose sources of help on an assignment, and the individual tests are still tests, even if you won't have someone watching over your shoulder.

You should probably avoid the various paid "homework help" websites. Most of these don't offer help. They offer worked solutions for a price. Getting those solutions won't help with your understanding. More importantly, the people working for these sites are paid (poorly) per solution, and they often provide incorrect and/or badly written work. ChatGPT is not much better (at least, not yet).

6. *Do I need a doctor's note?*

   No. This wastes health care resources and your time. (That was my answer before the pandemic, and it's doubly so now.) Just email me to say you were sick. However, if you miss more than one test due to illness, we'll need to meet to discuss how to adjust your grade.

7. *I receive learning accommodations. What arrangements can I make?*

   First, make sure that you have registered with the University's Accessible Learning Centre (`www.ulethbridge.ca/accessible-learning-centre`). No need to let me know: they notify me of every student with accommodations.

   If there are any adjustments I can make to facilitate your learning, please do not hesitate to get in touch with me. All students deserve an equal opportunity to learn. Note that the HTML textbook is designed with accessibility in mind, and should work with screen readers.

8. *Life intervened and I can't keep up this week. What do I do?*

   Send me an email, and I'll help you out as best I can. Book an appointment with me as soon as you feel like you're falling behind and I'll do my best to get you up to speed.