

Department of Mechanical & Industrial Engineering - University of Toronto

MIE563 – ANALYTIC AND NUMERICAL SOLUTION OF ENGINEERING PDES

Course Syllabus, Fall 2024

(version Sep 8, 2024)

Course Description: “A straightforward, no-BS approach to PDEs” –former MIE563 student

This course integrates and expands upon concepts of engineering analysis and numerical methods that you may have learned in previous years. The main learning outcome will be to understand the derivation and physical interpretation of engineering partial differential equations (PDEs) and their analytic solutions as much as the mechanics of solving PDEs. You will also gain a deeper intuition into engineering analysis techniques like Fourier series, eigenfunction expansions, special functions, as well as finite difference numerical methods, and how to use analytic solutions to verify numerical ones.

Course Instructor: Professor David A. Steinman, steinman@mie.utoronto.ca

Lecture Times: Mondays 3-5pm (GB120)
Tuesdays 10-11am (BAB024)

Tutorial Time: Thursdays 1-3pm (BAB026)

Office Hours: By appointment only; please email with sufficient advance notice

Required Text: Stanley J. Farlow. Partial Differential Equations for Scientists and Engineers. Dover Publications, 1993, ISBN 9780486676203

Course Website: <https://q.utoronto.ca/courses/363671>

Composition of Final Mark

Component	Marks	Description
Problem sets	20%	Worth 2.5 marks each on average, typically due a week after being assigned
Project	10%	Finite difference method verification project
Midterm test	30%	Type D (aids specified), tentatively Monday Nov 4
Final exam	40%	Same format as midterm test, date and time TBA

Nominal Course Schedule

Week #	Mon 3-5pm (GB120)	Tue 10-11am (BAB024)	Thu 1-3pm (BAB026)
1 Sep 9-13	Intro to course, PDEs, and review of ODEs (Ch 1)		<i>Tutorial & PS1 assigned</i>
2 Sep 16-20	Diffusion-type eqn & boundary conditions (Ch 2,3)		<i>Tutorial & PS2 assigned</i>
3 Sep 23-27	Heat eqn & separation of variables (Ch 4,5,7,8)	NO LECTURE	<i>Tutorial & PS3 assigned</i>
4 Sep 30-Oct 4	Inhomogeneities & eigenfunction expansions (Ch6,9)		<i>Tutorial</i>
5 Oct 7-11	Complex eigenfunction expansions & pulsatile flow (Ch 6,9,+)		<i>Tutorial & PS4 assigned</i>
6 Oct 14-18	NO LECTURE	Finite difference methods (Ch 37-39) & <i>Project assigned</i>	
7 Oct 21-25	Fourier series & intro to integral transforms (Ch 10,11)		<i>Tutorial & PS5 assigned</i>
8 Oct 28-Nov 1	READING WEEK		
9 Nov 4-8	MIDTERM (tentatively)		Fourier & Laplace transforms (Ch 12,13)
10 Nov 11-15	<i>Tutorial & PS6 assigned</i>		1D wave eqn derivation & D'Alembert solution (Ch 16,17,19,20)
11 Nov 18-22	<i>Tutorial & PS7 assigned</i>		Vibrating beams & drumheads (Ch 21,30)
12 Nov 25-29	<i>Tutorial & PS8 assigned</i>		Laplace-type eqns & boundary value problems (Ch 31,32)

Statement on Inclusivity

You belong here. The University of Toronto Engineering Faculty commits to all students, instructors, staff, alumni and partners that you can learn, create and participate in a welcoming, healthy and respectful environment. In this class, the participation and perspectives of everyone is invited and encouraged. The broad range of identities and intersections of identities within an inclusive team environment will help you achieve academic success. You can read the evidence for this approach here: <https://www.weforum.org/agenda/2019/04/business-case-for-diversity-in-the-workplace/>.

You are not alone. You are invited to talk to anyone in the Faculty that you feel comfortable approaching, including your professor, teaching assistant, academic advisor, any staff member, the Engineering Equity Diversity & Inclusion Action Group, a culture or identity club or group, or a U of T Equity Office.

Department Administrators: <https://gradstudies.engineering.utoronto.ca/grad-admins/>
Engineering Equity, Diversity & Inclusion Action Group & Clubs: www.uofteng.ca/edi
U of T Equity Offices: <https://hrandequity.utoronto.ca/inclusion/equity-offices/>

You have rights under the Ontario Human Rights Code that protect you against all forms of harassment or discrimination, including but not limited to acts of racism, sexism, Islamophobia, anti-Semitism, homophobia, transphobia, ableism and ageism. Engineering denounces unprofessionalism or intolerance of any kind, whether in person or online, on or off-campus. If you experience or witness any of these behaviours, please tell someone so we can help with resources and resolution. Engineering takes these reports extremely seriously. You can confidentially disclose directly to Marisa Sterling, P.Eng, Assistant Dean, Diversity, Inclusion and Professionalism.

Phone: 416.946.3986

Email: disclosure.engineering@utoronto.ca

Submit confidential disclosure form: www.uofteng.ca/disclosure

Ontario Human Rights Code: <http://www.ohrc.on.ca/en/students%E2%80%99-handouts/fact-sheet-1-ontario-human-rights-code>

Statement on Academic Accommodations

The University of Toronto supports accommodations for students with diverse learning needs, which may be associated with mental health conditions, learning disabilities, autism spectrum, ADHD, mobility impairments, functional/fine motor impairments, concussion or head injury, visual impairments, chronic health conditions, addictions, D/deaf, deafened or hard of hearing, communication disorders and/or temporary disabilities, such as fractures and severe sprains, or recovery from an operation.

If you have a learning need requiring an accommodation the University of Toronto recommends that students register with Accessibility Services as soon as possible. Register at: <https://studentlife.utoronto.ca/service/accessibility-services-registration-and-documentation-requirements/>

We know that many students avoid seeking help because they feel that they should not need “unfair advantages.” The purpose of academic accommodation is not to give an unfair advantage, but to help remove an unfair disadvantage. It may feel difficult to ask for help, but it can make all the difference during your time here.

Phone: 416-978-8060

Email: accessibility.services@utoronto.ca

Statement on Mental Health

Engineering at the University of Toronto is a demanding program. The workload and the frequency of assignments and tests can be challenging to balance and can feel overwhelming. As a result, students can find themselves experiencing physical and/or mental health issues which impact their academic performance and overall well-being.

If you find yourself feeling distressed and in need of more immediate support resources, consider reaching out to the counsellors at My Student Support Program (MySSP) (www.uoft.me/myssp) or visiting U of T Engineering’s Urgent Support – Talk to Someone Right Now webpage (<https://uofteng.ca/talknow>).

If you are encountering challenges that significantly affect your academic performance and overall wellbeing, there are a variety of free and confidential supports that can help you. As a U of T Engineering student, you have your Departmental Graduate Administrator (www.uoft.me/gradadmin) who can advise on personal matters that impact your academics. You can find helpful people, services and resources like these listed on the U of T Engineering Mental Health & Wellness webpage (www.uofteng.ca/mentalhealth) and SGS Health and Wellness Resources (<https://www.sgs.utoronto.ca/gradhub/resources-supports/#health-wellness>). A small selection is also included here:

- Accessibility Services (www.studentlife.utoronto.ca/as)
- Health & Wellness (www.healthandwellness.utoronto.ca)
 - On-Location Health & Wellness Engineering Counsellor (<https://www.sgs.utoronto.ca/resources-supports/graduate-wellness-services-at-sgs/>)
- Student Life Academic Success (<https://studentlife.utoronto.ca/department/academic-success/>)
- U of T Engineering’s Mental Health Programs Officer (www.uofteng.ca/mentalhealth#MHPO)
- SGS Financial Aid (<https://www.sgs.utoronto.ca/awards-funding/financial-aid-advising/>)

We encourage you to access these resources as soon as you feel you need support; no issue is too small.