

**ENGPYYS 2CM4
Computational Multiphysics
Undergraduate Studies
Fall/Winter 2020/21
Course Outline**

Current as of Mon Tue 2020-09-01 07:03:25; see the course Forum for the most up-to-date version of this document

CALENDAR/COURSE DESCRIPTION

Mathematical modelling and computational multiphysics for engineering design synthesizing E&M, thermodynamics, statics, dynamics, and quantum mechanics.
Three lectures, one lab (two hours each); first term

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): ENGPYYS 2P04, MATH 2Z03

Antirequisite(s): None

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Matt Minnick
BSB/B106
minnick@mcmaster.ca
ext. 24546

Office Hours:
All the time asynchronously via the course forum
Live via course forum during class time
Use the forum! :-)

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

TBA

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

Course Forum: Microsoft Teams

COURSE INTENDED LEARNING OUTCOMES

Upon successful completion of the course, you will be able to

1. look at any real world problem and tackle it using mathematical modelling (meaning that you understand how to apply the theory in your math & physics courses in a real-world context, and understand how to use modern tools to make the process more efficient than not mathematically modelling),
2. see the links between the physics content in mechanics, electromagnetics, heat transfer, fluid mechanics, quantum mechanics, and solid state physics in a way that lets you understand all areas more strongly, and
3. use scripting languages to automate computational tasks: e.g. setting up, running, and analyzing simulations.

MATERIALS AND FEES

COMPUTER:

Students should have a desktop or laptop capable of simultaneously running FlexPDE, Maple, and Microsoft Word (Windows machines are recommended, price point of \$300 or up should be fine). You will be required to use this for all deliverables in the course.

SOFTWARE:

Python, newest stable release (free online), FlexPDE Student Version (free online), Maple (Version 15 or higher), MS Word (2007 or newer), MS Teams (current version).

REFERENCE TEXTS:

-[Required] Course notes (free online)

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

Resources:

- Lecture notes & examples (online)
- Worked Example Practice Problems (online)
- Course videos explaining the notes & some practice problems each week (online)
- The forum, where you can get help from me, the TAs, and each other

The course is divided into 11 content weeks focused on **prep work** (work that is primarily for you to learn the material for your own benefit) followed by 2 weeks of **portfolio work** (work that is something you'd keep to show off to a potential employer). [See the Course Schedule](#) in the next section. In that schedule, prep work are the H1.1, H1.2, H1.3, H2.1, etc. deliverables that occur most weeks while portfolio work are the P1, P2, etc. deliverables at the end of the course (there are also 3 reflection surveys S1, S2, and S3).

Except for the reflection surveys (S1, S2, S3) which are private (but not anonymous) via quizzes, you'll submit all your assignments (i.e., prep work H1.1, H1.2, etc. or portfolio work P1, P2, etc.) publically through the course forum. Feel free to look at other people's assignments to learn more and be proud of them for their work! The forum is also the primary place to ask and get answers to questions. I'll hang out on the forum during all class times and myself and the TAs will check it regularly besides that as well, plus you can get help from other students too.

Your timeline for regular content weeks is as follows:

Weekend to Tuesday: working through notes, working through solution and neat thing learned

Tuesday during class time: finalize write-up if necessary; Q&A

End of Tuesday: HX.1 due

Thursday: working on finalizing HX.2; getting suggestions, writing up problem

Thursday evening: HX.2 due

Friday morning: HX.3 pairs assigned

Friday Lab: work on HX.3, meeting with partner if necessary.

Friday evening: HX.3 due

HX.1 means watch the weeks' video(s), read its notes, etc. and write up a solution to a variation of one problem you made while working through it that shows off something you learned in the process; explain something great you learned. **Due by 23:59 EST on Tuesdays**

To prepare for HX.1:

1. Watch and work through the week's videos, while reading & working through its notes
2. Try some of the practice problems with the help of the video
3. Try some of the problems on your own

Hand in: A variation on one of the problems this week (e.g., changing the question a bit and work through the solution, then comment on how the change affected it, whether this is expected and why; what does it mean?). Explain something great you learned in the process.

HX.2 means create a "totally" new (but related) practice problem you made yourself using this week's content for a classmate to try, and a solution write-up to it. You'll be partnered up and will have someone else do your problem, so need to make sure it's solvable (by submitting a solution as well!). **Due by 23:59 EST on Thursdays (see the schedule)**

Hand in: a write up of the problem, and a writeup of your example solution to it.

HX.3 means solve someone else's HX.2, writing up a variation solution (not just their solution) or solution to a variation problem and what it means, and something neat you learned in the process. **Due by 23:59 EST on Fridays (see the schedule)**

Hand in: the variation & solution write-up, commentary on the meaning of the solutions, and what you learned from it

The midterm & final design projects (i.e., portfolio work P1 & P2) are to create and solve a major problem that shows off everything (or as much as you can) that you've learned in the course for showing off to potential employers. Make and solve a problem which is a challenge for you, combining many of the previous topics, and implementing optimization.

This has 5 deliverables:

- P1.1 Write a proposal of what you're planning to do
- P1.2 Submit feedback on your partner's proposal
- P1.3 Submit a draft of your write-up of the project
- P1.4 Submit on someone else's draft, and
- P1.5 Submit your final version

(all are due by 23:59 EST on the day specified in the schedule)

COURSE SCHEDULE			
Date	Due	Topic	Description
Thu Jan 07	S1	Course Intro, Python, Rocketry, and Advanced Dynamics Problems	Computational Multiphysics Intro: Rocketry, Fluidic Drag, and other Advanced Dynamic Problems solved in FlexPDE and scripted using Python
Fri Jan 08			
Mon Jan 11	H1.1		
Tue Jan 12			
Thu Jan 14			
Fri Jan 15	H1.3		
Mon Jan 18		Heat Transfer	

Date	Due	Topic	Description
Tue Jan 19	H2.1		Time-dependent & Steady State Heat Equation with fixed temperature & insulating BCs
Thu Jan 21	H2.2		
Fri Jan 22	H2.3		
Mon Jan 25	H3.1	Advanced Heat Transfer & Computational Vector Calculus	Heat Eqn with Complex BCs, net flux, divergence theorem
Tue Jan 26			
Thu Jan 28			
Fri Jan 29	H3.3		
Mon Feb 01	H4.1	Electromagnetism and Maxwell's Equations	Modelling Electric and Magnetic Fields, Work, Stokes' theorem
Tue Feb 02			
Thu Feb 04			
Fri Feb 05	H4.3		
Mon Feb 08	P1.1	Design Project 1	Work on Design Project
Tue Feb 09			
Thu Feb 11			
Fri Feb 12	S2		
Mon Feb 15	Reading Week		
Tue Feb 16			
Thu Feb 18			
Fri Feb 19			
Mon Feb 22	P1.3	Design Project 1	Work on Design Project
Tue Feb 23	P1.4		
Thu Feb 25			
Fri Feb 26	P1.5		
Mon Mar 01	H5.1	Resonance and Eigenvalues	Modal analysis and its applications to waves, eigenstates of quantum systems
Tue Mar 02			
Thu Mar 04			
Fri Mar 05	H5.3+S2		
Mon Mar 08	H6.1	Thermal Expansion	Thermal expansion of solids
Tue Mar 09			
Thu Mar 11			
Fri Mar 12	H6.3		
Mon Mar 15	H7.1	Piezoelectrics	Piezoelectricity as a source of internal strain
Tue Mar 16			

Date	Due	Topic	Description
Thu Mar 18	H7.2		
Fri Mar 19	H7.3		
Mon Mar 22		Computational Multiphysics Integration	Combining & Reviewing the previous topics
Tue Mar 23	H8.1		
Thu Mar 25	H8.2		
Fri Mar 26	H8.3		
Mon Mar 29		Design Project 2	Work on Design Project
Tue Mar 30	P2.1		
Thu Apr 01	P2.2		
Fri Apr 02			
Mon Apr 05		Design Project 2	Work on Design Project
Tue Apr 06	P2.3		
Thu Apr 08	P2.4		
Fri Apr 09			
(Fri 16 Apr)	P2.5+S3	Design Project 2	

ASSESSMENT

This course uses schedule-driven grading. You start at A++ (i.e., the fictitious McMaster '13') and lose one grade point (i.e., A++ → A+, A+ → A, etc.) with every "missed" deliverable, meaning that you either didn't submit anything, didn't submit it on time, or what you submitted was not a reasonable honest effort on your part.

Exception 1: problems happen. If you submit something late (except where given an extension by an MSAF) you can either take the grade reduction (it's not the end of the world!) or work to overcome what went wrong that time and make up for it in the future by being at least 3 times as early as you were late on each of the next 3 deliverables.

Exception 2: You can't skip the final submission of the design projects; they just count as "missed" deliverables and becomes due again 3 calendar days later again and again until you submit them.

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Outcomes	Indicators
Can examine an engineering problem in any field and decide how to optimally tackle it with programming, with a CAS like Maple, and/or with FEM like with FlexPDE	04.1 - Recognizes and follows an engineering design process.(This means an iterative activity that might include recognizing the goal, specifying the constraints and desired outcomes, proposing solutions, evaluating alternatives, deciding on a solution, and implementing.)

Is able to successfully propose creative solutions for open-ended design projects	04.4 - Employs appropriate techniques for generation of creative ideas such as brainstorming and structured inventive thinking.
Demonstrates dedication to truly engineering solutions to meaningful problems in final design project	08.1 - Demonstrates an understanding of the role of the engineer in society, especially in protection of the public and public interest.
Able to seek external resources and extend course knowledge to solve exciting problems leveraging all tools available	12.1 - Critically evaluates and applies knowledge, methods and skills procured through self directed and self identified sources, including those that lie outside the nominal course curriculum.

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Engineering Physics is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

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. **It is your responsibility to understand what constitutes academic dishonesty.**

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. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

1. plagiarism, e.g. the submission of work that is not one's 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.

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, 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 a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

It is the students' responsibility to regularly check the course webpage (ATL) and forum for updates and announcements. Under normal circumstances, missed deadlines correspond to a reduction in grade as per the assessment section.

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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".

1. Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:
 - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
 - Students may submit requests for relief using the MSAF once per term.
 - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
 - a. Relief in this course means an extension on the due date of the deliverable(s) by 3 calendar days.

- The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
 - The MSAF cannot be used for academic work that has already been completed or attempted.
 - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
 - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.
2. For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:
- Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
 - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR 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 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.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.