ENGPHYS 2P04
Computational Mechanics
Undergraduate Studies
Fall/Winter 2021/22
Course Outline

Current as of Tue 2021-08-10 15:01:38; see the course Forum for the most up-to-date version of this document

CALENDAR/COURSE DESCRIPTION

Classical mechanics topics including coupled oscillators, elasticity, force and bending moment diagrams, tensors, Voigt notation, flexure, and beam resonance explored computationally using finite element method and computer algebra system software.
Three lectures, one lab (two hours each); first term

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): PHYSICS 1D03; and credit or registration in 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

See the Course Forum for TA info

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. Explain a variety of core principles in mechanics, both statics and dynamics
2. Use a computer algebra system (Maple) to solve a variety of physics and math problems
3. Use a FEM solver (FlexPDE) to solve partial differential equations on complex geometries

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:

FlexPDE Student Version (free online), Maple (Version 15 or higher), and MS Word (2007 or newer)

REFERENCE TEXTS:

-[Optional] Physics for Scientists and Engineers, Brooks Cole, Serway & Jewett, 978-1133947271 (same as first year)
-[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 (on YouTube)
-The forum, where you can get help from me, the TAs, and each other

Students are expected to regularly review the forum for new information and participate in the learning community it establishes by asking (and where possible answering) questions there.

The course is divided into 6 core content topics with deliverables focused on **prep work** (work that is primarily for you to learn the material for your own benefit) followed by a **portfolio work** design project (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 project is due at the end of the course (there are also 3 reflection surveys S1, S2, and S3).

Except for the self-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 the final project) publicly 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 frequent the forum during all class times and myself and the TAs will check it regularly besides that as well, plus you can and should offer each other help there too (and can earn participation bonus marks for doing so).

The course is divided into six core topic blocks (each lasting two weeks) followed by an independent final project. The topics in each 2-week block are as follows:

1. Phys 1D with Maple & FlexPDE (was Topic 1 in 2020)
2. Static Equilibrium and Trusses, Machines, and Equivalent Loads (were Topics 3 & 4 in 2020)
3. Internal Forces and Moments and Normal Elasticity (were topics 5 and part of 6 in 2020, but no FlexPDE)
4. Shear Elasticity & FlexPDE Statics (was Topic 7 in 2020)
5. Flexural Elasticity - Beam Bending (was Topic 8 in 2020)
6. Torsional Elasticity - Beam Twisting (was Topic 9 in 2020)

The schedule for each two-week topic (for the 10 weeks before the design project) is as follows (all meetings are on Teams):

1. Tuesday 1130 Lecture → Live lecture introing the topic
2. Thursday 1130 Lecture → time to watch the video; will have live office hours

3. Thursday 1130 Lecture → time to do practice problems; will have live office hours. *Prepare to be able to do practice problems yourself to get ready for the first Lab.*
4. Monday 1430 Lab:
    a. Meet with your TA who will run a practice problem session, introing the problem and helping you along, sending you to breakout rooms with other students to work on it.
    b. You'll submit a write-up of the practice problem: **HX.1**. "Due" at 1620, but can be submitted as late as 2359 without penalty if something goes wrong.
5. Tuesday 1130 Lecture → Live Review Lecture for topic
6. Thursday 1130 Lecture → Live office hours
7. Friday 1130 Lecture → Live office hours and time to finalize **HX.2** (creating and solving your own practice problem on the topic's content)
    a. Practice problem HX.2 is "due" at 1220 (but can be handed in as late as 2359 without penalty if something goes wrong)
8. Monday 1430 Lab:
    a. Meet with your TA; TA will have picked two of the best HX.2s for the group to tackle: half the group will tackle one of them and the other half will tackle the other one (if your problem was one of the two picked you'll be in the half doing the other problem!)
    b. Work [together] on your individual solution to the problem and reflection of the whole topic to hand in as **HX.3**, "due" at 1620 (but can be submitted as late as 2359 without penalty if something goes wrong).

RUBRICS FOR CORE CONTENT TOPICS HOMEWORK

Homework 1 (HX.1): Example of solving a problem enabled by this topic (started off by TA in the first lab of each 2-week block. "due" at the end of that lab but can be handed in as late as the end of the day without penalty):

Solved the problem correctly /5
Used their own solution /5
Explained their process and thinking /5
Reflect on and explain the meaning of the answer (not just a number - look back and say what it means and why) /10
Formatting and clarity /5

Homework 2 (HX.2): Created practice problem ("due" at the end of the last class before each lab, but can hand it in as late as the end of that day)

Problem:
Unambiguous and clearly explained (using diagrams where necessary) problem: /10
Clearly and appropriately aligned within the weeks' content: /10

Solution:
Solved the problem correctly /5
Used their own solution /5
Explained their process and thinking /5
Reflect on and explain the meaning of the answer (not just a number - look back and say what it means and why) /10

Formatting and overall clarity /10

Homework 3 (HX.3): solve a peer's problem assigned by the TA and reflect on the whole two weeks (work on during the lab; can and should work together to understand the problem as well as possible, as long as you hand in an individual solution. "Due" at the end of the lab, but if something goes wrong you can submit it as late as the end of the day)

Peer problem:

Solved the problem correctly /5
Used their own solution /5
Explained their process and thinking /5
Reflect on and explain the meaning of the answer (not just a number - look back and say what it means and why) /10
Formatting and clarity /5

Reflection on topic:

Explain: What do you feel are the most important concepts of this topic and why? /10

Final Project

Choose one topic from the 6 core topics (or one of the 3 bonus topics) and create a single large HX.2 for it that shows off your mastery of the topic and the course material as a whole. To do this, address the topic not just from the perspective of what you knew about it at the time we got to it, but in light of new information given the rest of the course's content too (later topics were already cumulative with earlier material so will be closer to how they were handled during the course compared to earlier topics).

You'll prepare a report on this (similar to the HX.2 reports from earlier but more polished and extensive), a 3-5-minute youtube (or alternative streaming site) video presentation briefly explaining it, and deliver a live presentation of it answering questions on the project and the topic you chose from your TA.

You may build on one of your homeworks from earlier in the course, or even include it as-is if it was already stellar and would be appropriate for this deliverable. Note that the expectations for polish and content mastery are higher for this than they were for an HX.2, so a project which earned a 70% on an HX.2 report might only receive a 35% if submitted as a final design project.

Flip-Flop Option

If you chose one of the 6 **core topics** for the final project you can take advantage of the flip-flop option - the final project will replace the mark you got on that topic (i.e., all 12% that the topic's deliverables were worth) if your overall mark on the final project is better.

Note: This is a good way to re-address a topic that didn't go so well at the time and make sure you leave the course with it really well understood.

Bonus Option

If you're really ambitious, instead you can choose one of the 3 **bonus topics** to base your final project on. If you cover one of these topics, then your design project will be worth an extra 5% (i.e., earning as much as a 5% bonus in the course if you get 100% on the design project).

Note: These topics are all valuable background info for future courses in Eng Phys, especially 2CM4.

The video should be at an appropriate level for someone familiar with the course content, but who hasn't necessarily read your report. Clearly explain the topic and problem you're tackling in it, your solution method, the solution resulting from it, and reflect on the problem and solution's meaning in the context of the course and beyond. You should use screen capture to show your work as you explain it, and should speak in the video, including manual or automatic subtitles. You may or may not have your face in it (your choice). Try to make the video as engaging and polished as you can within these guidelines. You'll submit the report and video link together in the course forum on their due date.

The live presentation will be booked by your TA. You should have your project material ready to discuss in answering TA questions, but you won't need to prepare a live "presentation" (your TA will watch your video first to get that information). The live Q&A will be about 5-10 minutes, and the TA may ask any questions about your project and the course topic it's based on, including its place in the context of the course.

To help you prepare for your final project, in addition to the information here, the whole class discussions live and in the forum, and the instructor office hours, you'll attend a live 5-10 minute 1-on-1 coaching meeting with your TA approximately 1 week before your project is due at a time that works for you. This meeting has grades associated with it (separate from the final project grades). Your work for this meeting is graded using the following rubric:
Preparedness: /5
Attendance: /5
Professional & enthusiastic participation: /5

Final Project Rubrics:

Report: (60% of the final project grade)
Problem:
- *Unambiguous and clearly explained (using diagrams where necessary) problem: /10*
- *Clearly and appropriately aligned within the topic's content: /10*

Solution:
- *Solved the problem correctly /5*
- *Used their own solution /5*
- *Explained their process and thinking /5*
- *Reflect on and explain the meaning of the answer (not just a number - look back and say what it means and why) /10*

Formatting and overall clarity /10

Video: (20% of the final project grade)
Clearly explained problem: /5
Clearly explained solution approach: /5
Problem and solution make sense for the topic: /5
Clear reflection on problem & solution and their meaning in the context of the course and beyond: /5
Video is engaging and polished: /5

Live Discussion: (20% of the final project grade)
Professionalism: /5
Project quality in light of discussion: /5
Project knowledge present: /5

Clearly demonstrated mastery of content: /10

PARTICIPATION BONUS

Participation in the course is key to success so to help you maximize your engagement in all aspects of the course there is an up-to-10% participation course weight replacement option. i.e., if your participation is excellent you'll get 10%; if it's good you'll get 7%, if it's OK you'll get 3%, and if it's poor you'll get 0%. Whatever % you get, it will replace that amount of your final grade with a 100% mark. e.g.,
Excellent participation: Grade = 10% + 90%*(rest of course grade)
OK participation: Grade = 3% + 97%*(rest of course grade)
Poor participation: Grade = rest of course grade (i.e., normal grading)

There are several ways to positively participate including:

1. Asking (and especially answering) meaningful honest questions in the forum to the best of your ability
2. Consistently attending classes and labs and positively participating (including having your camera on, working with groups in labs to tackle the content together, etc.)
3. Offering (and obtaining) live peer help in the class forum

You don't necessarily need to participate in all possible ways to achieve "good" or even "excellent" participation.

COURSE SCHEDULE

Date	Homework Due	Topic:
Tue 7 Sep		Core Topic Block 1: Phys 1D with Maple & FlexPDE
Thu 9 Sep		
Fri 10 Sep		
Mon 13 Sep	H1.1+S1	
Tue 14 Sep		
Thu 16 Sep		
Fri 17 Sep	H1.2	
Mon 20 Sep	H1.3	
Tue 21 Sep		Core Topic Block 2: 3. Static Equilibrium and 4. Trusses, Machines, and Equivalent Loads
Thu 23 Sep		
Fri 24 Sep		
Mon 27 Sep	H2.1	
Tue 28 Sep		
Thu 30 Sep		
Fri 1 Oct	H2.2	
Mon 4 Oct	H2.3	
Tue 5 Oct		Core Topic Block 3: 5. Internal Forces and Moments and 6. Normal Elasticity
Thu 7 Oct		
Fri 8 Oct		

Mon 11 Oct	***Mid-term recess***	
Tue 12 Oct		
Thu 14 Oct		
Fri 15 Oct		
Mon 18 Oct	H3.1	
Tue 19 Oct		
Thu 21 Oct		
Fri 22 Oct	H3.2	
Mon 25 Oct	H3.3	
Tue 26 Oct		Core Topic Block 4: 7 Shear Elasticity & FlexPDE Statics
Thu 28 Oct		
Fri 29 Oct		
Mon 1 Nov	H4.1	
Tue 2 Nov		
Thu 4 Nov		
Fri 5 Nov	H4.2	
Mon 8 Nov	H4.3	
Tue 9 Nov		Core Topic Block 5: 8 Flexural Elasticity - Beam Bending
Thu 11 Nov		
Fri 12 Nov		
Mon 15 Nov	H5.1	
Tue 16 Nov		
Thu 18 Nov		
Fri 19 Nov	H5.2	
Mon 22 Nov	H5.3	
Tue 23 Nov		Core Topic Block 6: 9 Torsional Elasticity: Beam Twisting
Thu 25 Nov		
Fri 26 Nov		
Mon 29 Nov	H6.1	
Tue 30 Nov		
Thu 2 Dec		
Fri 3 Dec	H6.2	
Mon 6 Dec	H6.3	
Tue 7 Dec		Final Project
7 - 12 Dec	Coaching for Final Project	
Fri 17 Dec	Project & S3	

ASSESSMENT

Assessment Item	Each	Number	Total
HX.1	2%	6	**12%**
HX.2	6%	6	**36%**
HX.3	4%	6	**24%**
Self Reflections	1%	3	**3%**
Final Project Coaching Meetings	3%	1	**3%**
Final Project	22%	1	**22%**
Participation			**Special bonus**
Grand Total			**100%**

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 mechanics and decide whether to optimally tackle it analytically, with a CAS like Maple, or with FEM like with FlexPDE	05.1 - Evaluates and selects appropriate modern tools.
Can use CAS and FEM solvers to solve mechanics problems computationally	05.2 - Demonstrates an ability to use modern/state of the art tools.
Can work with others to complete engineering work on time and communicate it digitally via professional documents in a forum	06.1 - Manages time and processes effectively, prioritizing competing demands to achieve personal and team goals and objectives.

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*, 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 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. Normal MSAF policy for 2P04 is a no-penalty 3-day extension on the deliverable, meaning you can hand it in up to 72 hours later than it was originally due (not the grace period, just the original due date) without deduction.
   - 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.