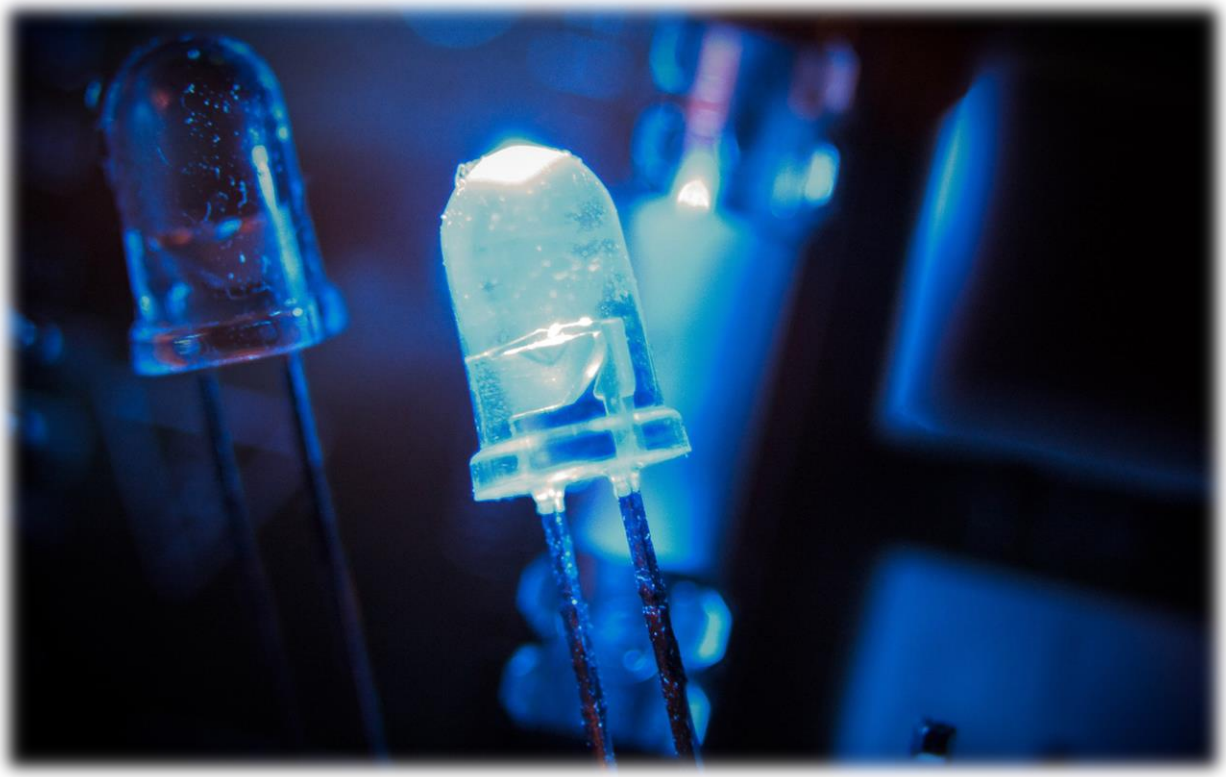
MIE366 – Electronics for Robotics



Instructor
Ameer Abdelhadi, ameer.abdelhadi@utoronto.ca

Office Hour
Monday 16:00-17:00 Via Zoom
https://utoronto.zoom.us/j/87646996029, Passcode: 025276

Additional office hours will be added near midterm and final.

Course Description

The course provides an introduction to circuit analysis and design for mechatronics applications. The focus is on building a working knowledge of: (1) op-amp circuits, (2) step response, steady-state response, and frequency response; (3) passive and active filter design; and (4) applications of the above to mechatronics systems, including sensors and instrumentation. The course will continue with a study of the fundamental behaviour and specific applications of the major semiconductor devices, including (5) diodes and (6) field effect transistors. Additional 'design assignments' will require students to design real-world viable circuits for mechatronics applications, and laboratory experiments will present additional applications for all circuits being studied.

Instructor

Instructor	**Ameer Abdelhadi**	**E-mail**	ameer.abdelhadi@utoronto.ca
Office	**Virtual via Zoom**	**Office Hours**	**Monday, 16:00-17:00**
Zoom link:	**https://utoronto.zoom.us/j/87646996029, Passcode: 025276**		

Teaching Assistants

Milad Haghi Kashani	Tutorial TA	m.haghikashani@mail.utoronto.ca
Armin Choopan	Lab TA	armin.choopani@mail.utoronto.ca
Pengfei Xu	Lab TA	pfxu@mie.utoronto.ca

Lecture and Tutorial Schedule

Lecture 0101	Wednesday, 12:00 – 14:00 (One additional weekly hour of recorded video or equivalent reading material will be posted online)	**FIRST LECTURE:** Sept. 15	**GB 304**
Tutorial 0101	Monday, 12:00 – 14:00	**FIRST TUTORIAL:** Sept. 20 (no tutorial on Sept. 13)	**GB 304**

Final Lab Schedule

	PRA 0101 **Thursday 15:00 - 18:00** **Room: MC 402**
Lab 1: Review of Equipment & PSPICE	Sept. 23
Lab 2: Active Filter Design	Oct. 7
Lab 3: Complex Active Filter Design and System Identification	Oct. 21
Lab 4: Diode Rectifiers & Regulators	Nov. 4
Lab 5: Digital Logic & Stepper Motor Driver	Nov. 18
Lab 6: The MOSFET as an Amplifier & Switch	Dec. 2

Course Text

Not a mandatory textbook, but recommended if you plan to continue in the field.

"**Microelectronic Circuits**", 5th Edition or newer, A. S. Sedra and K. C. Smith, Oxford University Press, 2004, ISBN: 9780195426717

List of Topics

- Review of frequency domain analysis
- Complex op-amp circuit analysis
- Bode plots and filter design
- Diodes, rectifiers, and regulator circuits
- Metal-oxide-semiconductor field-effect transistor (MOSFET) circuits
- Bipolar junction transistor (BJT) circuits

Learning Outcomes

At its core, this is a mechatronics design course. In lectures, we will study new electrical components and analytical techniques required to understand and build complex circuits. We will study learn the application of these circuits, and specifically how simpler circuits can be combined to potentially solve larger, more complex problems. We will organize the circuits into a "toolkit" of solutions, from which you can draw to construct solutions to open-ended engineering design problems in robotics and mechatronics. This design aspect will be reinforced by the design assignments, which require you to specify, design (conceptual and detailed), and iterate a number of partially constrained engineering problems. You will also prototype a number of solutions you design, both in the practical sessions and potentially in the final design assignment.

By the end of this course, each student should be able to:

- Understand basic theoretical principles and governing equations of new electrical components (i.e., diodes and transistors), and apply these principles to analysis of circuits.
- Analyze and deconstruct new circuits into smaller building blocks, build and maintain a "toolkit" of such building blocks, and arrange these elements into candidate solutions for larger, open-ended design problems.
- Follow the engineering design process for a robotic or mechatronics design problem, including specification, idea generation, conceptual, and final design of a circuit to complete a specific electrical task or goal.
- Follow formal design processes for well-known circuit types, such as filter design and power switching/power amplifier design. This includes the selection of real-world components and inclusion of real-world design issues, limitations, and constraints into a complete detailed design.
- Identify and incorporate issues related to electrical theory into a mechatronics design problem that are not immediately mandated as part of the problem, but are of crucial importance to its resolution (i.e., safety, design for failure modes, lifespan and wear, etc.)

- Build, test, and analyze prototyped solutions/circuits in a lab environment, which requires proficiency with the use of standard electronic test equipment (function generator, power supply, oscilloscope) and engineering tools and software related to electronic design (PSPICE, Eagle or other circuit CAD software).
- Understand the process, including constraints and limitations, of moving a circuit design from the prototype stage to a manufacturing-ready design (including PCB design and real-world design considerations for circuits).

Marking Scheme

Design Assignments	16%
Midterm Exam	21%
Practical Sessions	18%
Final Exam	45%
Total	100%

Design Assignments

The course will feature a number of **design assignments,** which are **individual** take-home mini-projects wherein you must **design and analyze** a circuit that accomplishes a given task of moderate complexity. These assignments are created to feature real-world problems, and have a double purpose: (i) to give you **graded** practice in the analysis of circuits similar to those found on the midterm and final exam, and (ii) to help you practice your **design** skills in Mechatronics. The second point is of crucial importance; you are now ready to apply the circuits you have seen in early courses and will see in MIE366 to solve useful, real-world problems. So, while this course will still teach the analysis of circuits with new components such as diodes and transistors, it will also focus heavily on the applications of these circuits. **We also hope, in at least one assignment, to have you build an actual product which you will keep**. This will be subject to availability of the design space and materials.

Tentatively there will be **four** design assignments, and the weight of each assignment will be announced with the assignment. The assignments are individual, and you will be expected to significantly document your **design process**, which includes an explanation and mathematical analysis of your final design. Later design assignments will require you to specify real-world components in your designs. A detailed set of instructions (including formatting, deliverables, and other common questions) will be posted with each assignment. The assignments will be provided roughly **one week** before we complete each major section in the course. You will then have roughly **two weeks** to complete the assignment, with the exception of the build-focused assignment. Exact dates and deadlines will also be posted with each assignment.

Midterm and Final Exam

The midterm date and location will be announced later.

The midterm and final exam are **closed-book, closed-notes**. A university-approved calculator and writing material are the only other material allowed. **The coverage of the midterm will be announced multiple times in class** during the weeks before the midterm. **Please do not send e-mails to the TAs or instructor asking what topics will be covered**.

If, for any reason, you are absent from the midterm, you must **submit a coursework petition form**, available online at the link provided below. Proof of your reason for missing the midterm must be included. Please do not send this proof or requests for accommodation to the instructor or TAs; we cannot help you until the online process is complete.

Should you miss the midterm (for a valid reason), the weight of your final exam will be increased to compensate. We are not able to provide individual make-up midterms, for reasons of fairness and academic integrity. Similarly, we cannot increase the weight of design assignments or labs to replace midterm weight; these are not considered closely supervised term work.

Please see the following for information about valid reasons to petition:

http://www.undergrad.engineering.utoronto.ca/Office_of_the_Registrar/Petitions.htm

Please see the following link to submit a petition for a missed midterm, or for any other coursework you miss or are otherwise unable to hand in:

http://uoft.me/termworkpetition

Tutorial Sections

The tutorials are held weekly in Galbraith Building, room GB 304. The first tutorial will be **Sept. 20th**. Tutorials cover exam-type examples related to the lecture material. Tutorial notes will be posted after each tutorial. Additional practice problems will also be provided to help you study. We do not post problems lists from the textbook, as they are not representative of the questions asked on the midterm and final. The tutorial problems provided on the course page are extensive (over 100 questions with multiple parts each, plus sample midterms and finals), and provide ample practice.

Laboratory / Practical Sections

Labs will start **Tuesday, Sept. 23rd** for the PRA 0101 section. Please follow the schedule shown on Page 2 for all lab sections.

Seats in room MC 402 are **very limited**. For this reason, please **be considerate** – DO NOT attend lab sections other than your own without prior permission from the instructor! Failure to follow this rule will result in a grade of **zero** for any work submitted for that lab. We regret having to add this rule, but this was a significant complaint in previous years, and we must respond accordingly. We hope that you can appreciate the need for this.

Lab handouts will be available from the course webpage before the lab time. Please note that each lab has a pre-lab component which will consist of reading and a deliverable.

- Generally, **it will not be possible to finish the lab in time** if you have not completed the pre-lab and read the rest of the lab procedure**.** Please note that we cannot currently provide access to all lab equipment after-hours, meaning your lab time is very valuable. Do not waste it by coming unprepared. Allowances will be made for significant equipment failure or other unavoidable problems during the lab itself.
- Lab reports are generally due at the **end of the lab session**, unless noted otherwise.
    - For Lab 2 through Lab 5, the **pre-lab** portion of the deliverable will be worth 0.5%, unless otherwise indicated, and the **remainder** (completed **in-lab**) is worth 2.5%. In total, each of these labs is worth 3% of the final grade.
    - For Lab 1 only, the total lab is worth 2%, composed of 0.5% for the pre-lab, and 1.5% for the remainder.
    - For Lab 6 only, the total lab is worth 4%, composed of 0.5% for the pre-lab, and 3.5% for the remainder.
- Labs are performed in **groups of 2**, which you should form during Lab 1. Occasionally, the TAs may allow a larger group (mostly in the case of significant equipment failure). In such cases, a TA **must sign off** on the increase, using the prescribed space on your deliverable sheet.
- For all hand-ins, please clearly indicate the **names and student numbers of all students** in your group. Groups will be **fixed** after the first lab session.
- For each lab, you will be given an **organized** set of parts; you are expected to return these parts in the same order and condition (excluding any regular wear and tear). The TAs are authorized to deduct lab marks if equipment is not returned or requires significant work to be made usable for the next group. Please be courteous and mindful of the groups that come after you.

Please note that we are in the process of making **significant** changes to the labs. These changes are the result of feedback from past years (formal and informal), changes in the field of Mechatronics, and feedback from industry. We hope that these new labs will flow better and teach you more relevant skills and topics than prior labs. That being said, we fully expect small issues to arise from time to time during the first run of these new labs. We kindly ask you to be understanding during this process, and we will do the same. We hope to make this a very good experience for you, with interesting and relevant content you can actually apply to real problems, especially in fourth year and in the workplace.

General Course Policies

Late Hand-ins

Please follow the hand-in schedule whenever possible. Late hand-ins without a valid petition will be penalized 20% per school day after the time they are due, no exceptions. Work cannot be accepted more than five school days after the hand-in deadline, or after solutions are posted, even in cases where a valid petition may be possible. For most valid petitions, weight will be re-assigned to other assignments to compensate for a missed deliverable. In all cases, a valid petition is needed for any accommodation; otherwise the late penalty will apply.

Safety Statement

As professional engineers in training, you have a duty of responsibility to ensure that safety is duly considered at all times. To this end, you are expected to behave with your personal safety and the safety of others in mind. In order to be allowed access to any undergraduate labs, including computer labs, it is mandatory that you complete the MIE online health and safety training course. Instructions for the completion of safety training requirements have been sent in an e-mail to all students. Safety training can also be accessed at: https://safetytraining.engineering.utoronto.ca/

Lecture and Tutorial Notes

The lectures will use very few Powerpoint slides – most information comes from hand-written examples. This course binder will contain schematics and space to write down all notes and examples from class. **You are responsible for completing these notes** – in particular, you should take the time to read the pre-reading before class; it will make the lectures much more relevant. Content you are responsible for in your studies is also clearly marked. I will not be posting or providing completed notes. In the case of absence, it is highly recommended to find a classmate to obtain any missed notes. Taking pictures of the board is allowed, but very much not recommended – it really misses the point of going to the lectures.

Plagiarism and Conduct

All students are expected to behave as professional engineers, and follow the rules of conduct outlined in your student handbook. All work is carefully checked for plagiarism, and exams will be carefully monitored by TAs and instructor. Cheating and plagiarism are serious academic offenses, and will be dealt with according to university policy.

Statement on Accessibility Services

Students with diverse learning styles and needs are welcome in this course. Please feel free to approach me or contact Accessibility Services (accessibility.services@utoronto.ca) so we can assist you in achieving academic success in this course.

Statement on Mental Health and Wellness

As a university student, you may experience a range of health and/or mental health issues that may result in significant barriers to achieving your personal and academic goals. The University of Toronto offers a wide range of free and confidential services and programs that may be able to assist you. We encourage you to seek out these resources early and often.

Student Life Website: http://www.studentlife.utoronto.ca

Health and Wellness Website: http://studentlife.utoronto.ca/hwc

If, at some point during the year, you find yourself feeling distressed and in need of more immediate support, visit the **Feeling Distressed Webpage**: http://www.studentlife.utoronto.ca/feeling-distressed, for more campus resources.

Immediate help is available 24/7 through **Good2Talk**, a post-secondary student helpline at 1-866-925-5454.

All students in the Faculty of Applied Science and Engineering have an Academic Advisor who can advise on academic and personal matters. You can find your department's Academic Advisor here:

http://undergrad.engineering.utoronto.ca/advising-support-services/academic-advising/.