

EP 4UB2
Modern and Applied Physics Laboratory - BioMedical

Undergraduate Studies
Make it your own!
Winter 2022
Course Outline

CALENDAR/COURSE DESCRIPTION

2 unit(s)

Students will complete the fabrication and testing of a working MOSFET/ISFET using semiconductor fabrication methods.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): one of ENGPHYS 3F03, 3PN4, or MATLS 3Q03, and registration in an Engineering Physics program.
Antirequisite(s): ENGPHYS 4U04, ENGPHYS 4U02

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. A. Turak
JHEA 321
turaka@mcmaster.ca
ext. 23448

Office Hours:
Wednesday – 2:30 pm
Or by appointment

S.A. McNamee
JHEA 304
mcmesa@mcmaster.ca
ext. 22657

Office Hours:
Thursday – 2:30 pm
Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Roderick MacLachlan
maclacr@mcmaster.ca

Office Hours:
TBD

Pedro Oliveria
oliveirp@mcmaster.ca

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://avenue.mcmaster.ca/> (Avenue to Learn, Avenue, A2L)
Meetings/discussions: [Zoom](#), [Teams](#)

COURSE INTENDED LEARNING OUTCOMES

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

- Understand the basic characteristics of a semiconductor device for sensing
- Develop application-specific devices from the design to implementation stage
- Understand the steps in the manufacture of such devices
- Produce a working biosensing device and understand the results of testing it

MATERIALS AND FEES

Required Texts: Documents in Avenue to Learn

Other Materials:

Access to a personal computer that can connect remotely to the SENTORIS simulation software.

COURSE FORMAT AND EXPECTATIONS

The course includes one 3-hour session per week, divided into three phases. The sessions will be used to introduce the topics, for oral presentations and demonstrations, and to work on various aspects of the course.

In Phase 1, students will develop a plan and proposed approach for using a CNT-FET device as a biosensor for a chosen analyte.

In Phase 2, students will simulate their proposed devices using SENTORIS.

In Phase 3, students will fabricate and test their devices.

The project and oral presentations will be performed in groups of two. The reports will be submitted individually, demonstrations will be performed individually, and the presentations will be graded individually. The course is focused on developing a biological sensor (biosensor) based on a semiconductor device such as a field effect transistor (examples of these types of sensors are presented in the paper bank on ATL).

Biosensing Proposal (Oral Presentation and Written Report)

The students will present their plan and proposed approach for building and simulating a biosensor in the form of a 15 minute oral presentation (+ 5 minute question and answer period) and a two-page document. In this proposal, they will present introduction, background and justification for the chosen topic, project objectives, proposed methods, and expected outcomes. The oral presentations will be held during the week of Jan 31st remotely, at a time finalized with the students during the first week of class. Oral presentations and the two-page document are evaluated individually for each presenter.

Simulation Checkpoint

During the week of Feb 28th, each group will demonstrate their device architecture and build in the simulation software to their TA and two other peer groups. The TA and the peer groups will assess the team's progress based on their progress and their understanding of the device operation and simulation setup.

**Device Testing
Demonstration**

During the week of March 28th, each group will demonstrate the testing of their FET devices to their TA. The TA will assess each student individually based on their experimental results and their understanding of the device operation, test setup, and the observed IV characteristics.

**Final Report (Oral
Presentation and
Written Report)**

The final report will have a written and oral presentation component and will be focused on the CNT-FET and biosensing aspects of the project, both simulated and built. The oral presentation will be a 20 minute video. The final written report (5 pages) should include the following sections: introduction of the biosensor and its operating principles; simulation model, fabrication process flow and modifications to the FET device; results and discussion of the simulation, device pictures, device IV curves before and after functionalization, before and after the introduction of the target. The final presentation videos will have a peer review component and will be made available during the week of April 4th for viewing. Oral presentations and the written document are evaluated individually for each presenter.

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| COURSE SCHEDULE |
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The objective of this course is to design, simulate, fabricate, and test a semiconductor device that can be used for biosensing applications. The students will learn to develop application-specific devices from the design to implementation stage and test a biosensing device.

| | | |
|----------------|---|------------|
| Week 1 | Introduction to biosensing lecture/proposal preparations | Remote |
| Week 2 | Proposal preparations | Remote |
| Week 3 | Proposal presentations | Remote |
| Week 4 | Introduction to simulations lecture/building simulation | Remote |
| Week 5 | Building simulation | Remote |
| | Reading Week | Off |
| Week 6 | Simulation check-in | Remote |
| Week 7 | Introduction to fabrication/safety lecture/fabricating device | In person* |
| Week 8 | Fabricating device | In person* |
| Week 9 | Fabricating device | In person* |
| Week 10 | Device Demonstration | In person* |
| Week 11 | Final Video Presentations | Remote |
| Week 12 | Final Report | Remote |

*Depending on the pandemic situation

This schedule is based upon current university and public health guidelines and may be subject to changes during the term. Any changes to the schedule or course delivery will be communicated on the course announcements section on Avenue to Learn. Please check the announcements prior to attending class.

ASSESSMENT

| Component | Due Date | Weight |
|--------------------------------|--------------------------------|--------|
| Biosensing proposal -- Oral | Week of Jan. 31 st | 15% |
| Biosensing proposal -- Written | Feb 4 th | 10% |
| Simulation checkpoint | Week of Feb. 28 th | 15% |
| Device Testing Demo | Week of March 28 th | 15% |
| Final Report -- Oral | Week of April 4 th | 20% |
| Final Report -- Written | April. 11 th | 25% |
| 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.

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.

AUTHENTICITY / PLAGIARISM DETECTION

Our course will use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

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.

Our course will use on-line elements (e.g. e-mail, Avenue to Learn (A2L), Zoom, Teams). 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, 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

1. It is the students' responsibility to regularly check Avenue to Learn for updates and announcements.
2. **How work is to be submitted:**
 - All submissions should be submitted through dropboxes on Avenue to Learn in pdf format.
3. **Policies on missed work, extensions, and late policies**
 - All course deliverables are due on the announced time and date. Failure to submit on time will result in a grade of ZERO.
4. **Group work expectations and how group work will be evaluated**
 - Group work is permitted provided all of the contributors' names are listed on the submission. Each person will be assessed individually.
5. **Participation expectations:**
 - For the video presentation, there is a peer evaluation component. Everyone is expected to watch and comment on everyone else's presentations; this will be counted as a component of your own presentation and report marks. The peer marks will be incorporated into the final mark for the presentation.
6. **Attendance requirements:**
 - Attendance at the organizational, presentation and check-in meetings are mandatory. Attendance during device fabrication and demonstration in person is mandatory.

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.
 - 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 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.