ENG PHYS 4Z04
Semiconductor Manufacturing Technology
Fall 2024
Course Outline

CALENDAR/COURSE DESCRIPTION

Detailed description of fabrication technologies used in the semiconductor industry; computer modeling of device fabrication; analysis of device performance.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): ENGPHYS 3F03 or MATLS 3Q03; and registration in the Faculty of Engineering or the Integrated Biomedical Engineering & Health Sciences (IBEHS) program.

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Gitanjali Kolhatkar   **Office Hours:** By appointment
JHE A318
kolhatkg@mcmaster.ca
ext. 24932

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

TBD   **Office Hours:** By appointment

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

http://avenue.mcmaster.ca/

COURSE INTENDED LEARNING OUTCOMES

The objective of this course is to introduce the theory and technology of semiconductor micro/nanofabrication. Two thirds of the course is lecture-based, where the theory of basic processing techniques will be discussed, spanning the formation of semiconductor wafer material to the finished device assembly.
One third of the lectures will be based in a classroom PC cluster. The students will learn to use state-of-the-art process simulators to virtually fabricate semiconductor chips and subsequently test their electronic properties.
The lab component will focus on solar cell microfabrication in the cleanroom. The students will learn standard cleanroom processes.
At the end of the course, students should have a good understanding of the various processing techniques used to micro/nano fabricate semiconductor devices; and to be able to simulate these processes using process simulators.

MATERIALS AND FEES

Required Text:
"Silicon VLSI Technology", J D Plummer, M D Deal, and P B Griffin, Prentice-Hall, 2000
Reference Text:
"Introduction to Microelectronic Fabrication: Volume 5 of Modular Series on Solid State Devices", Richard C. Jaeger, second edition, Prentice Hall, 2002
Calculator:
Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.
Other Materials:
All students require access to a laptop computer to perform course-related assignments and run simulations using Sentaurus software.

COURSE FORMAT AND EXPECTATIONS

The course includes one computer cluster-based lecture per week, one laboratory per week, and two classroom-based lectures per week. The course includes the following components.

Assignments	Two assignments will be presented by the instructor. These assignments will be posted on Avenue to Learn and will be due on the date specified. Assignments must be submitted individually. Late assignments will not be accepted and a grade of ZERO will be allocated.
Laboratory	The laboratories will be done in teams of three. Experiments will be conducted in the cleanroom with a TA and technician, with a maximum of two teams per day due to limited space in the cleanroom.
Group oral presentation	Oral presentations are in groups of 3. The general topic will be **the application of semiconductor devices**. Each team must choose a particular device that is currently being used or is under research AND is manufactured using the methods discussed in this course. You need to obtain topic approval from the TA by **October 31, 2023**. Presentations are evaluated individually for each presenter using the oral presentation rubrics.
Simulation Report	Simulation reports will **focus on the simulations developed through the tutorials**. You will have to simulate a PERL solar cell and write a report about your simulations. The reports are due individually through Avenue to Learn drop boxes on **November 4 at 11:59 PM**.
Project Report	Project reports will **focus on the labs**. The reports are due individually through Avenue to Learn drop boxes on **December 1st at 11:59 PM**. Late project reports will not be accepted and a grade of ZERO will be allocated.

COURSE SCHEDULE

Date/Week	Topic	Readings
1	Labour Day (No class Monday)	
2	Introduction to Semiconductor Technology, Review of Semiconductor Physics, Semiconductor Device Background	Chapter 1
3	CMOS Technology	Chapter 2
4	Wafers, Cleanrooms	Chapter 3,4
5	Guest Lecture	
6	Lithography	Chapter 5
7	Break	
8	Oxidation	Chapter 6
9	Doping	Chapter 7,8
10	Doping/thin films	Chapter 7,8, 9
11	Thin film Deposition	Chapter 9
12	Project Oral Presentation	
13	Project Oral Presentation	
14	Project Oral Presentation	

ASSESSMENT*

Component	Weight
Participation*	10%
Group oral presentation**	30%
Project report**	25%
Simulation report	15%
Assignments (two assignments)	20%
Total	100%

*The participation grade will be calculated based on participation in the classroom-based and computer-based sessions, laboratories, guest lectures, and student-led oral presentations.

** Graduate students are required to develop a publication-quality report and deliver a 40-minute presentation instead of 20 min.

MSAF policy:

- In the case of an MSAF, a two-day extension will automatically be granted.

The use of generative AI tools (e.g. ChatGPT, Google's Bard, Microsoft Bing) is strictly prohibited.

ACCREDITATION LEARNING OUTCOMES

Outcomes	Indicators
The students will learn the engineering processes involved in semiconductor manufacturing	

The students will learn to apply appropriate mathematical techniques to model semiconductor fabrication processes
The students will learn to select the appropriate physical models for predicting the outcome of semiconductor processes and will learn to identify assumptions and constrains
The students will learn to recognize and follow an engineering design process to design a process flow for fabricating a semiconductor device
The students will learn to propose solutions to open-ended problems during their Sentaurus project focused on designing a process flow for fabricating a semiconductor device
The students will learn to use state-of-the-art semiconductor processing software
The students will demonstrate an ability to respond to technical and non-technical questions through implementing their design project and preparing their final reports
The students will lean to present information clearly and concisely as appropriate to the audience

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

Some courses may 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.

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

1. It is the students' responsibility to regularly check the course webpage (*ex.* Avenue to Learn) for updates and announcements.
2. All course materials are due at the date, time, and format announced on Avenue to Learn. Failure to submit your work on time will lead to a grade of ZERO

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.