Engineering Physics
ENGPHYS 3L04
Engineering Metrology
Undergraduate Studies
Winter 2026
Course Outline

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Ray LaPierre

lapierr@mcmaster.ca

Office Hours:
By appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Contact the lab technician, Mohammadreza Shahzadeh <shahzm14@mcmaster.ca>, for any lab-related issues.
For other matters, contact the course instructor.

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

The official means of communication with students is via the course webpage on Avenue to Learn.
It is the students' responsibility to regularly check the course webpage for updates and announcements.

CLASS FORMAT

Course Dates: 01/05/2026 - 04/07/2026
Units: 4
Course Delivery Mode: All classes are in-person.
Course Description: Sensors for engineering measurements and selected topics in state-of-the-art technologies.
Prerequisite(s): Registration in Level III or above of any Engineering Physics program
Antirequisite(s): N/A

The course is scheduled as follows:

- C01: lecture Monday 8:30 – 9:20 am see Mosaic or Avenue for location
- C01: lecture Tuesday 8:30 – 9:20 am see Mosaic or Avenue for location
- C01: lecture Friday 10:30 – 11:20 am see Mosaic or Avenue for location
- L01: lab Monday 2:30 – 5:20 pm see Mosaic or Avenue for location

Recording of lectures is not permitted. Online lectures are not available.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to understand the following metrology topics:

- Electrical transducers

- Magnetic transducers
- Data analysis
- Dimensional metrology
- Force metrology
- Dynamic response
- Accelerometers and seismometers
- Angular-related metrology
- Pressure metrology
- Flow metrology
- Thermometry metrology
- Photodetectors
- Infrared devices
- Fiber optic devices
- Optical spectroscopy
- Radiation metrology
- Time & frequency metrology
- Quantum metrology
- The international system of units (SI)

By the end of this course, students should be able to:
i. Work with relevant statistics and error analysis at a level expected of a first introduction to engineers.
ii. Demonstrate knowledge of a wide range of measurement techniques and technologies relevant to industrial detection, monitoring, and control; as well as where to apply them.
iii. Be able to make the relevant connections between a wide range of measurement techniques and the underlying fundamental physics.
iv. Work hands-on with data acquisition from a range of different sensor types, and clearly report key results.
v. Be able to assess various aspects of the scientific and engineering literature.

ENGINEERING ACCREDITATION: GRADUATE ATTRIBUTES AND LEARNING OUTCOMES

The Canadian Engineering Accreditation Board (CEAB) is a division of Engineers Canada and is responsible for accrediting undergraduate engineering programs across Canada. Accreditation by the CEAB ensures that the engineering programs meet a national standard of quality and cover essential educational requirements. Graduate Attributes are a set of qualities and skills that the CEAB expects engineering graduates to possess. These attributes are a benchmark for the learning outcomes of accredited engineering programs. This section lists the Graduate Attribute Indicators associated with some of the Learning Outcomes in this course.

The Graduate Attributes 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.

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
I	1.1, 1.3, 2.3
Ii	1.3, 1.4, 2.1, 4.3
Iii	1.2, 3.1
Iv	5.1, 5.2, 5.3, 7.1, 7.2, 7.3
V	12.1

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

LAB INFORMATION

This course includes 4 labs and a project. Details are provided in Avenue.

LAB SAFETY

Refer to the lab manuals in Avenue.

COURSE SCHEDULE

This lecture 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.

Date/Week	Topic	Readings/Topic
1	Lecture 0-1	Electrical transducers
2	Lecture 2-4	Electrical transducers, magnetic transducers, data analysis, statistics
3	Lecture 5-7	Signal processing, dimensional metrology
4	Lecture 8-10	Force metrology, dynamic response, accelerometers
5	Lecture 11-13	Angular metrology, pressure metrology
6	Midterm recess	
7	Lecture 14-16	Flow metrology, thermometry
8	Lecture 17-19	Thermometry, photodetectors
9	Lecture 20-22	Photodetectors, infrared devices, fiber optic devices
10	Lecture 23-25	Optical spectroscopy
11	Lecture 26-28	Radiation metrology, time and frequency metrology
12	Lecture 29-31	Time and frequency metrology, quantum metrology
13	Lecture 32-34	Quantum metrology, international system of units
14	Lecture 35-36	International system of units

REQUIRED/OPTIONAL MATERIALS AND FEES

Required Texts:
None

Recommended Additional Texts (Optional):

1) A.J. Wheeler, Introduction to Engineering Experimentation (3rd edition, Pearson, 2010).
2) J.P. Holman, Experimental Methods for Engineers (8th edition, McGraw-Hill, 2012).
3) J.G. Webster and H. Eren, Measurement, Instrumentation, and Sensors Handbook (2nd edition, CRC Press, 2014).

Calculator:
Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

Other Materials:

An Arduino and sensor lab kit is required for this course and will be provided. Details are provided in "Lecture 0: Course Outline" posted in Avenue.

COURSE ASSESSMENT DETAILS

Component	Due Date	Weight
Labs 1-4	Refer to "Lecture 0" posted in Avenue	12%
Project proposal	Refer to "Lecture 0" posted in Avenue	3%
Project expo/demo	Refer to "Lecture 0" posted in Avenue	15%
Project report	Refer to "Lecture 0" posted in Avenue	20%
Final Exam	TBD	50%
Total		100%

GRADING SCALE

The McMaster 12 Point Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

MSAF policy:

- Lab 1-4 MSAFs will be made-up on Feb 9. If the make-up lab is missed, the grade component will be moved to the final exam.
- Expo/demo MSAFs: contact the instructor (LaPierre)
- Report MSAF: grade will be moved to the final exam.

GENERATIVE AI

USE PROHIBITED

Students are not permitted to use generative AI in this course. In alignment with McMaster academic integrity policy, it "shall be an offence knowingly to … submit academic work for assessment that was purchased or acquired from another source". This includes work created by generative AI tools. Also state in the policy is the following, "Contract Cheating is the act of "outsourcing of student work to third parties" (Lancaster & Clarke, 2016, p. 639) with or without payment." Using Generative AI tools is a form of contract cheating. Charges of academic dishonesty will be brought forward to the Office of Academic Integrity.

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 and the Faculty of Engineering are 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.

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 ONLINE ELEMENT

This course has no online components.

ONLINE PROCTORING

This course has no online components.

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.

ACADEMIC ADVISING

Academic Advisors are available to assist you with any problems or questions you may have. This includes course selections, changes to your enrolment, McMaster Student Absence Form (MSAF), Religious, Indigenous, or Spiritual Observances (RISO) forms, exams, taking courses at another university (for credit at McMaster), Petitions for Special Consideration, and much more. Below is the contact information for the Office of the Associate Dean (Academic) in the Faculty of Engineering:

JHE-Hatch 301
https://www.eng.mcmaster.ca/programs/academic-advising
(905) 525-9140 ext. 24646

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the Student Wellness Centre.

REQUESTS 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". An abbreviated version is provided below.

The University recognizes that students periodically require relief from academic work due to extenuating circumstances. Students seeking relief for missed academic term work are expected to read the ***McMaster Student Absence Form Policy***. The Policy aims to manage these requests by taking into account the needs and obligations of students, instructors and administrators. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in their course. Any concerns regarding the granting of relief should be directed to the Faculty Office.

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three (3) 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 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 (3) 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 **not** occur during this course. 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.