IBEHS 4F04

Biomedical Instrumentation and Measurement

Fall 2023

Course **Outline**

Calendar/Course Description

An introduction of engineering principals applied to the design of biomedical instrumentation including: clinical laboratory testing instruments, electrophysiology systems (ECG, EEG, EMG, etc.), minimally invasive endoscopic and laparoscopic instruments, respiratory devices, therapeutic devices; safety; and other clinical instrumentation.

Pre-Requisites and Anti-Requisites

Prerequisite(s): IBEHS 3A03 and registration in the Integrated Biomedical Engineering and Health Sciences (IBEHS) program

Antirequisite(s): ELECENG 4BD4

Course Schedule

The delivery of this course occurs through 3 modules, **lectures**, **tutorials**, and laboratories (**labs**). Lectures and tutorials occur weekly while labs occur biweekly.

LECTURES: Tuesdays 12:30-13:30 & Thursdays 12:30-14:20

- *Objective*: Main content delivery through in person lectures

TUTORIALS: T01 Wednesdays 13:30-14:20 BSB 137; T02 Mondays 9:30-10:20

- *Objective*: Assignment/test take up, and Q&A with TA/Instructors

LABORATORIES (LABS): between 14:30-17:20 every 2 weeks (check your schedule on Mosaic).

- *Location*:
- *Objective*: In group setting, experiential learning of clinical lab microscopy, EMG, ECG, EEG, and EOG instrumentation.

Instructor Office Hours and Contact Information

Dr. Joseph Hayward
TBD
haywardj@mcmaster.ca

Office Hours:

- By appointment only

Instructional Team

TAs: Each Lab section will have some of the following TA's

- Daniel Duan, duand2@mcmaster.ca
- Jackson Sholdice, sholdicj@mcmaster.ca
- Tianqi Hong, hongt6@mcmaster.ca
- Hailey Wang, wangh467@mcmaster.ca
- Enas Osman, osmane@mcmaster.ca

Additional Instructional Support

Laboratory Technician: manages the laboratory space; provides training on use of equipment; supports all project and lab activities

Leela Pilli
Office: ETB-534
Email: pillil@mcmaster.ca

Course Delivery

Avenue-to-Learn and IBEHS 4F04 Microsoft Teams will be the online management systems for the course. Through **Avenue**, you will be able to:

- Find all course materials (lecture slides, lab materials, assignments, etc.)
- View course-related announcements
- Submit course work (lab reports, project deliverables) for grading
- View your gradebook

The course's Team (IBEHS 4F04 2023) will be used primarily for interactive communications between the instructional team and the students, as well as among group members of the lab module.

Materials and Fees

Required Textbooks
Medical Instrumentation: Application and Design
John G. Webster, Amit J. Nimunkar,
Wiley, 5th Edition, ISBN: 978-1-119-45733-6 June 2020
https://www.wiley.com/en-ca/Medical+Instrumentation%3A+Application+and+Design%2C+5th+Edition-p-9781119457336

Optional Textbooks
Principles of Biomedical Instrumentation
Andrew G. Webb
Cambridge, 2018, ISBN: 9781107113138
https://doi.org/10.1017/9781316286210

Software

All software is free to download and install for McMaster students and is also available on computers in ETB-534 via remote access.

- MATLAB R2022a with the following toolboxes:
  - Computer Vision Toolbox
  - Image Processing Toolbox
  - Image Acquisition Toolbox
  - Signal Processing Toolbox
  - Data Acquisition Toolbox
  - NI-DAQmx Support from Data Acquisition Toolbox
- NI-DAQmx Drivers

Course Objectives and Learning Outcomes (LO)

Disclaimer: The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be taken into consideration in determining a student's actual grade in the course.

Upon successful completion of the course, the student should be able to:

LO.01	Analyze a measurement or instrumentation problem and propose a solution.
LO.02	Apply the principles of electronic circuits and devices to design instrumentation.
LO.03	Have knowledge of the principles and use of a variety of electrical and other transducers, analog and digital instrumentation, applied computer signal acquisition and processing.
LO.04	Apply current safety standards in design.
LO.05	Understand the principles and efficacy of instrumentation used in cardiopulmonary, neurological, surgical, analytical and rehabilitation areas of medicine.

Assessments

The course is assessed as follows.

GRADING MODULE	WEIGHT
Labs	**40%**
Lab 1: Microscopy	(8%)
Lab 2: Differential Amplifiers and EMG	(8%)
Lab 3: ECG	(8%)
Lab 4: EEG	(8%)
Lab 5: EOG	(8%)
Assignments	**5%**
Midterm	**20%**
Final Exam	**35%**

6F04 Option and the Accelerated Masters Program

This course can be taken as BME 6F04 that may be counted towards the accelerated M.A.Sc. degree in the School of Biomedical Engineering. This option is only available to McMaster's students in the undergraduate 4 or 5-year Integrated Biomedical Engineering & Health Science (IBEHS) program whereas the accelerated degree may be completed in 12 months of full-time study. Application for entry into the accelerated option occurs in the penultimate year of undergraduate studies. To choose this option, general registration of IBEHS 4F04 and permission from the instructor are required. An additional graduate level module will be required in addition to all 4F04 requirements.

Completion and Submission of Work

It is the student's responsibility to ensure assessments are correctly submitted to the correct location, on time, and in the specified format. ***Failure to correctly submit an assignment will result in a mark deduction*** (see below).

Submission Penalties

Documents must be uploaded to avenue by the deadline, or they will be subject to a late penalty of **1% per hour**

Any submissions deemed to be partially or fully copied will be considered an academic offence and be subject to terms laid out under the Academic Integrity Policy.

Important Dates

Fall Term	
Thursday September 7	Introductory Lecture. Tutorial & Labs start the following week
October 9 – 13	**Fall Reading Week (no classes, labs, tutorials)**
October 26	Midterm Test (in class, tentative)
December 8 – 21	**Fall Term Examinations** (the date of **Exam** is TBD)

Communication Policy

Need help and have questions related to the course? We want to make sure your questions get answered. To ensure this, it's important that the correct communication method is used.

Please direct all emails to: qiyin.fang@mcmaster.ca. Every attempt will be made to reply within 24 hours (excluding weekends). Please include a subject prefix of "IBEHS 4F04". Emails must be sent from your @mcmaster.ca account. Be sure to include your student number in your email.

Inclusive Environment Statement

We consider this classroom to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

We will gladly honour your request to address you by an alternate name or gender pronoun. Please advise of this preference early in the semester so that we may make appropriate changes to our records.

Accreditation

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 actual grade in the course. For more information on Accreditation, please visit: https://www.engineerscanada.ca. Mapping of the course **Learning Outcomes (LO)** to the Canadian Engineering Accreditation Board (CEAB) **Graduate Attributes (GA)** are outlined in the table below:

GRADUATE ATTRIBUTE	LEARNING OUTCOME(S)
GA01 - Knowledge Base for Engineering 1.4 – Competence in Specialized Engineering Knowledge 1.2 – Competence in natural sciences	
GA03- Knowledge Base for Engineering 3.1 – Recognizes and discusses applicable theory knowledge base 3.3 - Estimates outcomes, uncertainties and determines appropriate data to collect.	
GA04- Engineering Design 4.2 - Recognizes and follows engineering design principles including appropriate consideration of environmental, social and economic aspects as well as health and safety issues. 4.6 - Determines and employs applicable standards and codes of practice.	
GA08 Societal Impacts 8.1 - Demonstrates an understanding of the role of the engineer in society, especially in protection of the public and public interest. 8.2 - Demonstrates an understanding of legal requirements governing engineering activities (including but not limited to personnel, health, safety, and risk issues).	
GA13 – Ethics & Equality 13.4 - Ethics and Responsibilities - Recognizes and values the importance of dealing ethically with uncertainties, diversity, intra and intergenerational equity and other nontechnical challenges which affect engineering decision making	

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

McMaster Approved Policy Statements

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 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:

- Plagiarism, e.g., submission of work not one's own or which other credit been obtained.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.

Authenticity / Plagiarism Detection

In this course we will be using a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. Students will be expected to submit their work electronically either directly to Turnitin.com or via Avenue to Learn (A2L) plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish to submit their work through A2L and/or Turnitin.com must still submit an electronic and/or hardcopy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com or A2L. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). To see the Turnitin.com Policy, please go to the following website: www.mcmaster.ca/academicintegrity.

Academic Accommodations for 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 Accommodation for Religious, Indigenous, or Spiritual Observations (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 examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Academic Accommodations for Relief for Missed Academic Work: McMaster Student Absence Form (MSAF)

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".

- All MSAFs are to be directed to prof1p10@mcmaster.ca. Sending to another email address will delay processing.
- It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.
    - In the event an MSAF is applied to either the **Graphics Design Final Assessment** or **Computing Final Assessment**, they **will be rescheduled**.

Courses with an On-Line Element

In this course, we will be using **Avenue-to-Learn** and **Microsoft Teams**. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, usernames 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 this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

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.

Reference to Research Ethics

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to https://reo.mcmaster.ca/.

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.

Notice Regarding Possible Course Modification

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

Integrated Biomedical Engineering & Health Sciences (IBEHS) Labs/Design Studio Safety

Information for Laboratory Safety and Important Contacts

This document is for users of IBEHS instructional laboratories at the following locations:

- ABB C104 (Design Studio)
- ETB 533 (Medical Imaging/Biomaterials Lab)
- ETB 534 (Medical Instrumentation/Robotics Lab)
- HSC 4N72 (Genetic Engineering Lab)

This document provides essential information for the healthy and safe operation of IBEHS instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in IBEHS. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory.

Details on Standard Operating Procedures (SOPs), Health and Safety videos and other resources can be found online at the iBioMed Health and Safety webpage.

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

- Food and beverages are not permitted in the instructional laboratories.
- A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
- Laboratory equipment should only be used for its designed purpose.
- Proper and safe use of lab equipment should be known before using it.
- The lab tech or course TA leading the lab should be informed of any unsafe conditions.
- The location and correct use of all available safety equipment should be known.
- Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
- Proper waste disposal procedures should be followed.
- Personal ergonomics should be practiced when conducting lab work.
- Current University health and safety issues and protocols should be known.

Location of Safety Equipment

Fire Extinguisher: on walls in halls outside of labs or within labs

First Aid Kit: ABB C104, ETB 533, ETB 534, HSC 4N72 or dial “88” after 4:30 p.m.

Telephone: on the wall of every lab near the door

Fire Alarm Pulls: Near all building exit doors on all floors

Who to Contact?

Emergency Medical / Security:

On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

Hospital Emergency Medical / Security:

For McMaster HSC, call Security at extension **5555** or **905-521-2100** from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the Lab Tech, TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency):

Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See Lab Tech, TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs.

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

IBEHS Specific Instructional Laboratory Concerns: For non-emergency questions specific to the IBEHS laboratories, please contact appropriate personnel below from a McMaster phone:

- Leela Pilli, Laboratory Technician – 26888
- Parmveer Bola, Instructional Assistant – 23521
- Andrej Rusin, Wet Laboratory Technician – 28347
- Alexa Behar-Bannelier, Program Manager – 24548

In Case of a Fire (Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people.

1. Douse with water from safety shower immediately or
2. Roll on the floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if a blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents. Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In Power Lab, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol for Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you are not sure, ask!

Defined Roles

IBEHS Lab Technician	Leela Pilli, pillil@mcmaster.ca
IBEHS Instructional Assistant	Parmveer Bola, bolap1@mcmaster.ca
IBEHS Wet Lab Technician	Andrej Rusin, rusina@mcmaster.ca
IBEHS Co-Directors	Dr. Colin McDonald, cmcdona@mcmaster.ca Dr. Michelle MacDonald, macdonml@mcmaster.ca
IBEHS Program Manager	Alexa Behar-Bannelier, alexa.behar@mcmaster.ca
IBEHS Course Instructor	Please contact your specific course instructor directly