EP 3L04
Industrial Monitoring and Detection Techniques
Fall/Winter 2018/19
Course Outline

CALENDAR/COURSE DESCRIPTION

Industrial and process measurement systems, instrument response and uncertainty, modeling process systems. Fundamental physics of instrument measurement methods. Instrumentation reliability and safety system design.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in Level III or above of any Engineering Physics program
Antirequisite(s): Eng Phys 3L03, 4L03, 4L04

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

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Office Hours:
By appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

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COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

Avenue to Learn
http://avenue.mcmaster.ca/

COURSE OBJECTIVES

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

- Demonstrate knowledge of a wide range of measurement techniques and technologies relevant to industrial detection, monitoring, and control.
- Be able to identify the main sources of noise and interference in measurements, and propose viable options for improving measurement results.
- Be able to make the relevant connections between a wide range of measurement techniques and the underlying fundamental physics.

- Understand the basic aspects of feedback and control.
- Be able to assess various aspects of the scientific and engineering literature which are relevant to defined engineering goals.

MATERIALS AND FEES

Required Text: {new}

EP 3L04 custom courseware.

Recommended Additional Texts:

"Measurements and Their Uncertainties", Ifan Hughes and Thomas Hase (Oxford, 2010)
"Engineering Signals and Systems", Second Edition, Fawwaz Ulaby and Andrew Yagle (NTS Press, 2016)
"Mechatronics", Sixth Edition, William Bolton (Pearson, 2015)
"The Art of Electronics", 3rd Edition, Paul Horowitz and Winfield Hill (Cambridge University Press, 2015)
"Feedback Systems: An Introduction for Scientists and Engineers", Karl Åström and Richard Murray (Princeton University Press 2008)

Calculator:

Only the McMaster Standard Calculator will be permitted in tests and examinations.

Other Materials:

Other relevant resources will be recommended during the semester on our Avenue to Learn site.

COURSE OVERVIEW

This section outlines the general strategy for Engineering Physics 3L04 in fall 2018. It should be noted that this represents the tentative plan for the coverage of material, and we will undoubtedly make some adjustments as we proceed through the semester. The central goal of the course is to consider a wide range of physical principles, mathematics, and technologies which are relevant to engineering measurements. Although the lectures will concentrate on a substantial number of the topics listed below, some of the topics will be mainly covered via assignments, labs, tutorials and demonstrations, and guest lectures.

The following is an outline of some of the main resources which we plan to utilize, but note that there are also journal articles from the scientific and engineering literature which will form a basis for our studies.

1. Overview of Measurement Systems [Chapter 3, "Measurement Systems" in the book "Measurement and Data Analysis for Engineering and Science" by Patrick Dunn (CRC Press, 2010)]

2. Pervasive Measurements in Engineering – Flow, Pressure, Temperature, and Mechanical
   - Overview of fluids [based on various resources outside of CCW]
   - Flow measurements [based on various resources outside of CCW]
   - Pressure (including vacuum) [based on various resources outside of CCW]

- Thermodynamics and Temperature Measurements [based on Chapter 8 from "Experimental Methods for Engineers" by Holman, and sections of Chapter 9, "Measuring Pressure, Temperature, and Humidity", Wheeler and Ganji, "Introduction to Engineering Experimentation"]
- Selected Mechanical Measurements and Actuation [Chapters 8 and 9 in "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" (6th Edition), by William Bolton (2015)]

3. Physics and Technology of Ultrasound [based on various resources outside of CCW]

4. Dynamic Behaviour of Measurement Systems [based on Chapter 11 of "Introduction to Engineering Experimentation" by Wheeler and Ganji (Prentice Hall, 2010)]

5. Vibrations [based on Chapter 6 from "The Physics of Metrology" by Hebra (Springer-Verlag, 2010)]

6. Waves from moving Sources ["Introduction to the Physics of Waves" by Freegarde (Cambridge, 2013)]

7. Two selected aspects of telecom technology [based on "Optical Fiber Communications" by Keiser]
   - Optical receiver operation
   - Digital link (technical) budgets

8. Physical Models for Imaging [based on "Introduction to Subsurface Imaging" by Saleh (Cambridge, 2011)]

9. Selected applications of laser spectroscopy in engineering, and coherent measurement techniques [based on "Laser Spectroscopy 2: Experimental Techniques" by Demtröder (Springer-Verlag, 2015)]

10. Light Sources and Optical Fiber Sensors [based on resources outside of CCW; and on selected material from Chapter 9, "Measuring Pressure, Temperature, and Humidity", in the book by Anthony Wheeler and Ahmad Ganji, "Introduction to Engineering Experimentation" (Prentice Hall, 2010)].
    - Diode Lasers in some detail; other solid state and fiber based sources very briefly
    - Fiber-optic sensors

11. Radioactivity [based on resources outside of CCW; and "Radioactivity Measurement", by Coursey, Chapter 80 of Part VIII of "Measurement, Instrumentation, and Sensors Handbook", Webster and Eren, CRC (2014)]
    - Brief overview of collisions and cross sections for a wide domain of interactions
    - Radioactivity

12. Detectors – Electromagnetic Radiation and Nuclear Particle Radiation [based on Chapter 12 "Thermal and Nuclear Radiation Measurements" in the book "Experimental Methods for Engineers" by Holman (McGraw Hill, 2012); as well as selected resources from the literature.]
    - Detectors for EM and particle radiation

13. Feedback and Control – A Brief Introduction [based on selections from "Feedback Systems: An Introduction for Scientists and Engineers", K. Åström and R. Murray (Princeton, 2008); and Chapter 6, "Stability, Sensitivity and Robustness" of "Feedback and Control for Everyone", by Albertos and Mareels]
    - Overview of control
    - Stability

14. Quantum Metrology [based on "Introduction to Quantum Metrology", Waldemar Nawrocki (Springer, 2015); and selected sources from the literature]
    - Overview of quantum metrology
    - Example of atomic clocks

15. Essential Relativity for Engineering Measurements [based on resources outside of CCW]
    - Relativistic kinematics
    - Special and General Relativity for GPS

16. Specific case studies [based on "Aerospace Engineering on the Back of an Envelope" by Alber (Springer, 2012), as well as resources outside of CCW]
    - Science and technology for nuclear waste disposal
    - Engineering and technology for underwater applications including deep sea
    - Technical performance of the Hubble Space Telescope

17. Telemetry [based on "Telemetry", by Albert Lozano-Nieto, Chapter 90 of Part IX of "Measurement, Instrumentation, and Sensors Handbook"; Edited by John Webster and Halit Eren, CRC Press (2014)]
    - Introduction; frequency and time division multiplexing

18. Two Common Technical Issues [based on Chapter 1, "The Interference Problem" in the book "Noise Reduction Techniques in Electronic Systems", and on Chapter 20, "Thermal Control", by Philip Hobbs; as well as selected other sources outside of CCW]
    - The basis of interference and noise issues in measurements
    - Thermal effects

19. Reliability and Safety [Chapter 1 in "Practical Reliability Engineering"; and "Aerospace Engineering on the Back of an Envelope", Alber (Springer, 2012); as well as selected resources from the literature];
    - Basic ideas on reliability
    - Selected safety considerations

ASSESSMENT

Component	Weight #1	Weight #2	Weight #3
Assignments	30%	30%	30%
Lab Reports (2)	10%	10%	10%
Participation	15%	15%	15%
Mid-term Test(s)	30%	15%	0%
Final Exam	15%	30%	45%
Total	100%	100%	100%

Note 1: You will be given the best evaluation scheme, provided that the stipulation of Note 2 is satisfied.
Note 2: In order to be offered the best score (Weight #1 versus Weight #2 versus Weight #3), it is necessary that one writes the tests and scores at least 25% on each of them to be able to benefit from the options. Please be careful not to "cut things too close" in preparing for the tests.

Note 3: Participation, to a substantial extent, takes into account involvement in group work sessions and on-campus facility tours, as well as participation in lab sessions where no report is required.

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 actual grade in the course.

- Select appropriate measurement tools and techniques, in particular for temperature, pressure and flow monitoring, based on fundamental knowledge of the methods as well as the common practice for deployment. [1.3, 2.2]
- Apply basic engineering approaches to instrument calibration, based on the fundamental science for system response, combined with a practical appreciation of the typical parameters associated with the calibration of common measurement sensors and equipment. [2.1, 2.2]
- Demonstrate good writing skills through the delivery of succinct technical reports. [7.1, 7.3]
- Demonstrate the ability to utilize scientific and technical literature, and engineering-device-specific information. [12.1]
- Ability to connect the various technical topics under consideration with the basic physical principles studied in prior courses. [1.3]
- Identify sources of noise and interference based on a combination of fundamental knowledge and device-specific practical information. [1.3]
- Identify key elements of engineering reliability and safety analysis, at an introductory level, relevant to the design of mainstream instrumentation utilized for mechanical, electrical, nuclear and optical-based measurement systems. [1.3, 4.5]
- Employ engineering error analysis, extended from the fundamental treatments in previous core courses, to its application in the analysis of hands-on experiments. [2.1, 2.3]
- Work effectively within a small team, and also achieve the appropriate balance between the team work and the expected individual deliverables. [6.1, 6.2, 6.3]
- Tackle an engineering design problem at an introductory level which incorporates diverse elements in terms of required engineering knowledge. [2.1, 4.3]
- Implement basic aspects of optical measurements at a non-specialist and introductory level in solving simple design problems. [1.4, 4.3]

For more information on Accreditation, please see the relevant document in the Miscellaneous folder in our ATL site.

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.

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.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity

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.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities.

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

1. The McMaster Student Absence Form is a self-reporting tool for Undergraduate Students to report absences DUE TO MINOR MEDICAL SITUATIONS that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note this tool cannot be used during any final examination period.
2. You may submit a maximum of 1 Academic Work Missed request per term. It is YOUR responsibility to follow up with your Instructor immediately (NORMALLY WITHIN TWO WORKING DAYS) regarding the nature of the accommodation. Relief for missed academic work is not guaranteed.
3. If you are absent for reasons other than medical reasons, for more than 3 days, or exceed 1 request per term you MUST visit the Associate Dean's Office (JHE/H301). You may be required to provide supporting documentation.
4. This form must be submitted during the period of absence or the following day, and is only valid for academic work missed during this period of absence.
5. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.
6. You should expect to have academic commitments Monday through Saturday but not on Sunday or statutory holidays. If you require an accommodation to meet a religious obligation or to celebrate an important religious holiday, you may submit the Academic Accommodation for Religious, Indigenous and Spiritual Observances (RISO) Form to the Associate Dean's Office. You can find all paperwork needed here: https://www.eng.mcmaster.ca/programs/academic-advising

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.

TURNITIN.COM STATEMENT

In this course we will be using a web-based service (Turnitin.com) to reveal plagiarism. Students will be expected to submit their work electronically to Turnitin.com and in hard copy so that it can be checked for academic dishonesty. Students who do not wish to submit their wok to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to http://www.mcmaster.ca/academicintegrity/.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using e-mail and Avenue to Learn. Students should be aware that, when they access the electronic components of this course, 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 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.

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 http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.