EP 3L04
Industrial Monitoring and Detection Techniques
Fall/Winter 2016/17
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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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:
EP 3L04 custom courseware.

Recommended Additional Texts:
"Feedback Systems: An Introduction for Scientists and Engineers", Karl Åström and Richard Murray (Princeton University Press 2008)
“Introduction to Mechatronics and Measurement Systems”, Fourth Edition, David Alciatore and Michael Histand (McGraw Hill, 2012)
"Engineering Signals and Systems", Second Edition, Fawwaz Ulaby and Andrew Yagle (NTS Press, 2016)
"Instrumentation and Control Systems", Second Edition, William Bolton (Newnes, 2015)
“Mechatronics”, Sixth Edition, William Bolton (Pearson, 2015)

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 plan for Engineering Physics 3L04 in winter 2017. It should be noted that this represents the tentative plan for the coverage of material, but 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.

After an initial overview, four general domains of measurement which are pervasive in engineering are considered – flow, pressure (including vacuum), temperature, and selected mechanical measurements. This will be followed by a treatment of mechanical and electrical actuators.

We will briefly study a technology which is utilized in diverse applications – ultrasound. Beyond the fact that it is widely used in industry and the medical domain, it provides an excellent review of waves, which are ubiquitous in

engineering. This also lays a basis for a few selected topics in photonics. We will consider some key optical sources and explore fiber optic sensors briefly. Beyond the relevance for specialists, optics and photonics provide diverse enabling tools for engineers who undertake projects in diverse domains.

Next we will cover detectors. This treatment will be broadly targeted – optical, IR, x-ray and gamma ray, and particle detectors. Basic aspects of radioactivity will be considered in connection with the discussion of radiation detection.

We will briefly explore the domain of Fourier optics. This is being introduced, not solely for its use directly in the optical domain, but rather due to the importance and generality of the concepts. We will go on to tie this to a survey of selected imaging approaches.

Next we will consider some essential aspects of feedback and control will complement the goal of our third and final laboratory experiment. This is a very important area of engineering, and could even turn out to be very useful for your capstone project.

This is followed by the topic of telemetry, which will be treated briefly. The content is aimed at the current theme of detection and monitoring in engineering measurements, but there are aspects which are transferable to mainstream communications engineering.

As we are getting close to the end of the course, we will take up two specific topics – noise and interference, and heat transfer – considerations which often lead to problems in instrumentation and engineering applications.

At the end, we take an introductory look at reliability engineering and selected safety considerations.

Finally, I will mention that we have a lot of latitude in what we undertake exactly in this course, so we can, and likely will, alter some of the game plan as we proceed. 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]

2. Pervasive Measurements in Engineering – Flow, Pressure, Temperature, and Mechanical
   - Overview of fluids (very briefly)
   - Flow measurements [based on various resources outside of CCW]
   - Pressure (including vacuum) and Temperature Measurements [based Chapter 9, “Measuring Pressure, Temperature, and Humidity”, in the book by Anthony Wheeler and Ahmad Ganji, “Introduction to Engineering Experimentation”]
   - Selected Mechanical Measurements [based on “Acceleration, Vibration, and Shock Measurement” Chapter 36 of Part IV of “Measurement, Instrumentation, and Sensors Handbook” edited by John Webster and Halit Eren, CRC Press (2014)
   - Actuators [based on Chapter 8 and Chapter 9 in "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" (6th Edition), by William Bolton (2015)]

3. Light Sources and Optical Fiber Sensors [based on Chapter 4, “Optical Sources”, in “Optical Fiber Communications” by Gerd Keiser as well as selected articles and to cover high power solid state and fiber lasers; and based on Chapter 9, “Measuring Pressure, Temperature, and Humidity”, in the book by Anthony Wheeler and Ahmad Ganji, “Introduction to Engineering Experimentation”].
    - LEDs and Diode Lasers in some detail; and high-power solid state and fiber lasers (very briefly)
    - Fiber-optic sensors (briefly)

4. Review of Cross Sections; and Radioactivity [based on resources outside of CCW; and on “Radioactivity Measurement”, by Bert Coursey, Chapter 80 of Part VIII of “Measurement, Instrumentation, and Sensors Handbook” Edited by John Webster and Halit Eren, CRC Press (2014)]
    - Brief overview of collisions and cross sections for a wide domain of interactions
    - Radioactivity

5. Detectors – Electromagnetic Radiation and Nuclear Particle Radiation [based on Chapter 7, “Detectors”, from the text “Building Scientific Apparatus: Fourth Edition”; and on Chapter 12 “Thermal and Nuclear Radiation Measurements” in the book “Experimental Methods for Engineers”; as well as selected sources from the literature.]
    - Detectors for EM and particle radiation

6. Fourier Optics and Imaging [based on "Fundamentals of Photonics", 2nd Edition, Chapter 4, Bahaa Saleh and Malvin Teich (Wiley, 2007)]

7. Feedback and Control – A Brief Introduction [based on "Instrumentation and Control Systems", 2nd Edition, William Bolton (Newnes 2015) and "Feedback Systems: An Introduction for Scientists and Engineers", Karl Åström and Richard Murray (Princeton University Press 2008)]

8. 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

9. 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 sources on the internet.]
    - A brief recap from EP 2A04; Maxwell’s equations and electromagnetic radiation
    - The basis of interference and noise issues in measurements
    - A brief recap of thermal physics
    - Thermal effects

10. Reliability and Safety [based on Chapter 1, “Introduction to Reliability Engineering” in the book “Practical Reliability Engineering”; as well as selected resources from the literature]
    - Basic ideas on reliability
    - Selected safety considerations

ASSESSMENT

Component	Weight #1	Weight #2	Weight #3
Assignments	25%	25%	25%
Lab Quiz	5%	5%	5%
Lab Reports (2)	10%	10%	10%
Participation	10%	10%	10%
Mid-term Test(s)	30%	15%	0%
Final Exam	20%	35%	50%
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.

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/A214). 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: http://www.eng.mcmaster.ca/current/documents.html

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.