Western University  
Faculty of Engineering  
Department of Electrical and Computer Engineering

ECE 3374A - Electronics for Mechanical Engineers

COURSE OUTLINE – 2019-2020

CALENDAR DESCRIPTION:  
This course deals with the study of electrical, electronic, and electromechanical devices and systems, including the theory of operation, and analysis of behavior through modelling of components and systems.

COURSE INFORMATION:  
Instructor: Dr. J.E. Makaran, P.Eng.  
Email: jmakaran@uwo.ca  
Lectures: Tu 7:00 pm – 10:00 pm NS-7  
Labs: M 6:30 pm – 9:30 pm SEB 3107  
Th 7:00 pm – 10:00 pm SEB 3107

PREREQUISITES:  
ECE 2274A/B or ECE 2238A/B.

ANTIREQUISITES:  
ECE 227A/B, ECE 3332A/B, ECE 3333A/B, ECE 3375A/B.

CONSULTATION HOURS:  
By advance notice via email.

ACCREDITATION UNITS:  
Engineering Science = 60%, Engineering Design = 40%

TOPICS:  
1. Passive Component Behaviour and Circuit Analysis

Students will review voltage, current, and power relationships in discrete components such as resistors, capacitors, and inductors under DC and AC conditions. Students will use analytical techniques to understand the operation of simple circuits using passive components. Theoretical principles will be reinforced through simulation, construction, and operation of simple circuits. Electrical analogs for mechanical parameters such as torque, velocity, and inertia shall be presented.

2. Signal Conditioning

Students will be introduced to filter and amplifier circuits (such as those incorporating op-amps) that are used in signal conditioning applications. Theoretical principles will be reinforced through simulation, construction, and operation of simple circuits. Applications to sensors that are used to measure physical parameters such as temperature, pressure, force and displacement will be briefly discussed.
3. **Power Electronic Devices used in Energy Conversion**

The principle of operation, physical construction, and system level application considerations of the following devices shall be studied:
- Diodes
- Power MOSFETs
- IGBTs
- Electrolytic Capacitors

Special attention shall be given to loss generation and modeling of static and transient thermal behaviour using information specified in data sheets as a criterion for device application.

4. **Electric Motors**

The following electric machines shall be studied:
- DC brush motors
- Synchronous (permanent magnet) electronically commutated motors
- Single phase and three phase asynchronous motors
- Reluctance (stepper motors)

The construction and speed / torque behavior of each machine shall be presented. Attention shall be given to factors affecting efficiency. Speed control means shall be presented. The function of the motor as part of an overall system, such as in systems used in linear actuation, or in systems incorporating pumps and fans shall be modelled through the use of electromechanical analogs for transient and steady-state operation.

The study of electric machines shall continue with a discussion of application specific selection of appropriate machines from data sheets and catalogs that are reinforced through simulation and design exercises.

5. **Electronic Packaging and Manufacturing**

A review of electronic packaging and assembly processes shall be presented. Thermal management and environmental protection means shall be reviewed, along with an overview of typical quality issues and various means to perform root cause failure analysis of systems incorporating electronics.

6. **Validation of Systems Incorporating Electronics**

An overview of the manner in which mechatronics systems are validated at the system level shall be presented. Test plans according to a client Design Validation Plan (DVP) shall be presented, along with specific test modalities, such as thermal testing, mechanical testing, electrical testing, and environmental testing. Validating critical component interfaces and testing to failure to understand product shortcomings shall be discussed.
**LEARNING OUTCOMES:**

- Understand voltage, current, and power relationships in passive components
- Understand electrical analogs for mechanical components.
- Simulate and analyze simple circuits used to condition physical signals
- Understand the theory of operation of power electronic devices used in energy conversion.
- Understand system level considerations in the application of systems incorporating power electronic devices.
- Perform static and transient thermal modelling on assemblies containing power electronic devices.
- Understand component derating and its importance on electronic device application.
- Understand the system level influences on electronic device reliability.
- Understand device failure modes and their system level implications.
- Understand the theory of operation and construction of electric motors typically used in industry, including factors affecting efficiency.
- Model mechanical systems incorporating electric motors.
- Select the appropriate type and size of motor for a given application.
- Verify, compare and interpret differences between the results obtained through system level simulation and experimentation
- Understand the processes used to manufacture electronics, along with typical quality issues that are associated with electronic manufacturing and packaging means.
- Create test plans for products from application specific information.

**CONTACT HOURS:**
3 lecture hours, 3 lab hours, half course

**RECOMMENDED TEXTBOOKS:**
Selected readings based on lecture content

**EVALUATION:**
The final course grade will be determined according to the following weighting scheme:

- Mid-term exam (closed book) Thursday, October 24th 30%
- Laboratory sessions 20%
- Final examination (closed book) 50%

**COURSE POLICIES**
The following course-specific policies will be enforced throughout the course:

**Laboratory sessions**
- Failure to pass the laboratory component of the course will attract automatic course failure.
• Passing of the laboratory component is equivalent with obtaining more than 50% on the laboratory component of the course.
• A maximum of one make-up session will be offered to students who have missed a laboratory session with academic consideration.
• Missing of a laboratory session without academic consideration will translate into a zero mark for that laboratory session.

**Final examination**
• Only non-programmable calculators will be allowed during the final examination.
• If a minimum of 50% is not obtained on the final examination, the student cannot receive a final mark greater than 48%.

**Submissions**
• Lab reports will be due at the end of the lab session in which data was collected
• Late submission of the SW tutorials will be penalized with 20% per day
• Late submission of the project will be penalized with 20% per day
• Final exam will be three hours long and will be submitted at the end of the allotted time

**UNITS:** Metric and US customary.

**ENGLISH:** In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests and examinations for the improper use of English. Additionally, poorly written work with the exception of final examinations may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

**CLASSROOM Demeanor:** The instructor is committed to providing a respectful learning environment for all students involved in this course. This is a collective responsibility of the instructor and students, and therefore students partaking in this course agree to abide by this criterion. This includes arriving at lectures on time, and acting in a professional manner during class.

**ATTENDANCE:** Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

**CHEATING:** University policy states that cheating, including plagiarism, is a scholastic offense. The commission of a scholastic offence is attended by academic penalties which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Calendar).

**SSD:** Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with
Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**NOTE:** Students who have failed an Engineering course (i.e. < 50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years.