Western University
Department of Electrical and Computer Engineering

ECE 3374A - Introduction to Electrical Engineering for Mechanical Engineers

COURSE OUTLINE – 2021-2022

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:	Classroom sessions. FNB 1250 Tuesdays 6:30 – 9:30 pm
Labs:	Mondays and Thursdays 6:30 – 9:30 pm in SEB 3107 according to schedule Lab exercises will be in the form of laboratory experiments including simulation exercises using Microcap, Matlab, and Simulink where appropriate

COVID CONTINGENCY:

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online at the discretion of the course instructor.

PREREQUISITES:

Restricted to yr 3 & 4 Mechanical Engineering Students or yr 3 integrated or yr 2 Integrated/HBA, Integrated, or Mechanical/HBA students.

ANTIREQUISITES:

Antirequisite(s): ECE 2274A/B, MSE 3302A/B, the former ECE 3373A/B. The former ECE 2274A/B, ECE 3373A/B, MSE 3302

COREQUISITE:

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

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.

2. DC and Steady State AC Analysis

Students will review node voltage and mesh current analysis in both DC and AC circuits. Phasor notation will be introduced to study voltage, current, and power relationships in single-phase, and three phase wye and delta connected AC circuits. Thévenin and Norton equivalent circuits will be studied in both AC and DC circuits. The concept of power factor will be introduced along with VAR compensation.

3. 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.

4. 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. A review of electronic packaging and assembly processes shall be presented. Thermal management and environmental protection means shall be reviewed.

5. 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 for transient and steady-state operation.

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

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:

Upon successful completion of this course, students will:

- Understand voltage, current, and power relationships in passive components. (KB4)
- Understand electrical analogs for mechanical components. (KB4)
- Perform voltage, current and power calculations in DC and AC circuits. (PA3)
- Perform power factor calculations in single phase and three phase AC circuits. (PA3)
- Determine Thévenin and Norton equivalent circuits employing resistive and reactive components. (KB4)
- Simulate and analyze simple circuits used to condition physical signals. (ET2)
- Understand the theory of operation of power electronic devices used in energy conversion. (KB4)
- Understand system level considerations in the application of systems incorporating power electronic devices. (KB4, PA3)
- Perform static and transient thermal modelling on assemblies containing power electronic devices. (ET2)

- Understand component derating and its importance on electronic device application. (KB4, IN3, EE1)
- Understand the system level influences on electronic device reliability. (KB4, EE1)
- Understand device failure modes and their system level implications. (KB4, IN3, EE1)
- Understand the theory of operation and construction of electric motors typically used in industry, including factors affecting efficiency. (KB4)
- Model mechanical systems incorporating electric motors. (ET2)
- Select the appropriate type and size of motor for a given application. (D3)
- Verify, compare and interpret differences between the results obtained through system level simulation and experimentation. (ET2)
- Understand the processes used to manufacture electronics, along with typical quality issues that are associated with electronic manufacturing and packaging means. (KB4, IESE2)

CONTACT HOURS: 3 lecture hours, 3 lab / tutorial hours, half course. The lab and tutorial schedule will be made available during the first week of classes.

RECOMMENDED TEXTBOOKS: Electrical Engineering – Principles and Applications – 7th Edition, Hambley, A.R., Pearson, 2018

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

Evaluation	Date	Value
Test Units 1 and 2	Second Week of October (Week of October 11th)	20%
Test Unit 3	Last Week of October (Week of October 25th)	15%
Test Unit 4	Third Week of November (Week of November 15th)	15%
Final exam	TBD During Fall Exam Period. Covering units 5 and 6	20%
Laboratory Sessions	4 labs Throughout Term – Starting the week of September 20th	20%
Participation	Ongoing	10%

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

Computer Requirements

All students are to ensure that they have a laptop computer that will be used during class sessions or when working on labs and in-tutorial exercises.

Tests and examinations in this course will be conducted in person.

Laboratory sessions

- All students are to attend their assigned lab or tutorial sessions **with no exceptions**.
- Lab sessions will be held in-person.
- Lab reports will be due at the end of the assigned lab session. No late submissions will be accepted.
- Failure to pass the laboratory component of the course will attract an 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.
- A mark of 0% will be assigned to students who have missed a laboratory session **without** academic consideration.
- All approved make-up laboratory sessions will be offered in the final week of the term.
- When academic consideration has been obtained for a particular laboratory session, it is the student's responsibility to contact the instructor of the course in a *timely* fashion in order to seek alternate arrangements for the missed laboratory session (*i.e.*, within 24 hours after consideration has been obtained from the Engineering Undergraduate Services Office).
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Term Tests and Final Examination

- Failing to achieve a grade of 50% in tests and the final examination components of the course will result in an automatic course failure.
- Term tests and examinations will be delivered in-person. The use of a single page, double-sided formula sheet will be permitted in these evaluations.
- Only non-programmable calculators and a double-sided formula sheets will be allowed to refer to during term tests
- Term tests will be 1.5 hours long and will be submitted at the end of the allotted time.

- The final exam will take place during the December examination period and delivered in person. Its timing will be announced in advance.
- The final exam will be two hours long and will be submitted at the end of the allotted time.
- Only non-programmable calculators and a double-sided formula sheets will be allowed to refer to during the final exam.

Missed Tests and Examinations

- A mark of 0% will be assigned to students who have missed a term test or the final examination **without** academic consideration.
- **No make-up quiz** will be offered to those who miss a term test with academic consideration. The weighting of missed quizzes with consideration will be shifted automatically to the final exam. There will be no exceptions !
- When academic consideration has been obtained for a particular missed term test or final exam, it is the student's responsibility to contact the instructor of the course in a *timely* fashion (*i.e.*, within 24 hours after consideration has been obtained from the Engineering Undergraduate Services Office).
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

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.

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.

Components of this course will involve live interactions. To ensure the best experience for both you and your classmates, please honour the following rules of etiquette:

- Please arrive to class on time
- Please use your computer and/or laptop if possible (as opposed to a cell phone or tablet)
- Please maintain focus on the class material during lectures. Use of the Internet for other than course related activities is discouraged.

You will be required to display your name at all times in every lecture on a single, folded, sheet of plain, white, 8.5" x 11" sheet of paper with your name written on it in block letters, using a black marker so as to be clearly visible from a distance of 25 m.

Attendance will be taken during lectures, and will factor into the participation mark.

Note that disruptive behaviour of any type during classes or laboratories, is unacceptable. Depending on the severity, the actions may be subject to disciplinary measures under the Code of Student Conduct.

USE OF RECORDINGS:

Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

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:

Cheating is stealing. Engineering is a profession with a code of ethics. Students are expected to behave in a manner consistent with the PEO Code of Ethics. 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). If cheating during any course evaluation is suspected (including lab assignments), the student will receive a mark of zero for that particular evaluation.

ACCOMMODATIONS:

Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: Academic Accommodation for Students with Disabilities.

ACADEMIC CONSIDERATION FOR STUDENT ABSENCE:

Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- For exams scheduled by the Office of the Registrar (e.g., December and April exams)
- Absence of a duration greater than 48 hours,
- Assessments worth more than 30% of the student's final grade,
- If a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are *not* met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Missed labs or evaluations without accommodation shall result in a mark of zero for that lab or evaluation. Missed evaluations with an accommodation shall be completed by the student within a timeframe determined by the course instructor. The missed evaluation may not be identical to the missed evaluation at the discretion of the course instructor, however, will require the student to demonstrate competence in the same course outcomes as the missed evaluation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For Western University policy on Consideration for Student Absence, see Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs
and for the Student Medical Certificate (SMC), see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

RELIGIOUS ACCOMMODATION:	Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar.