Western University
Department of Electrical and Computer Engineering

ECE 3374A - "Introduction to Electrical Engineering for Mechanical Engineers"

COURSE OUTLINE – 2022-2023

CALENDAR DESCRIPTION:

ECE 3374a 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 as well as lab exercises.

COURSE INFORMATION:

Instructor:	Dr. J.E. Makaran, P.Eng. SEB 3095 Email: jmakaran@uwo.ca
Lectures:	Classroom sessions. Talbot College 341 Wednesdays 6:30 – 9:30 pm
Labs:	Mondays 3:30 – 6:30 pm and Tuesdays 7:00 – 9:00 pm in SEB 3107 according to schedule Lab exercises will be in the form of laboratory experiments including pre-lab simulation exercises using Microcap, Matlab, and Simulink where appropriate

Students must use their Western (@uwo.ca) email addresses when contacting the instructor, and use appropriate / agreed upon forms of address as well as e-mail etiquette.

Contingency plan for an in-person class pivoting to 100% online learning

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, affected 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 as determined by 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

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: Meetings are by appointment and may either be in-person, or via Zoom. Appointments are to be requested via email in advance of the meeting.

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.
- Understand electrical analogs for mechanical components.
- Perform voltage, current and power calculations in DC and AC circuits.
- Perform power factor calculations in single phase and three phase AC circuits.
- Determine Thévenin and Norton equivalent circuits employing resistive and reactive 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.

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.

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

REFERENCES: Other references may be used in this course at the discretion of the professor

TECHNICAL REQUIREMENTS: Students will be expected to have a computer that is capable of running the entire MS Office set of software, including but not limited to; Excel, and Word as well as Microcap and Matlab/Simulink.

In the event a pivot to online learning is required, students will be expected to have a stable internet connection.

UNITS Metric and US customary. ISO symbols will be used as well.

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

Evaluation	Date	Value
Test Units 1 and 2	Week of October 3rd	25%
Test Unit 3	Week of October 24th	25%
Test Unit 4	Week of November 21st	25%
Final exam	TBD During Fall Exam Period. Covering units 5 and 6	25%
Laboratory Sessions	4 labs Throughout Term – Starting the week of September 20th	20%
Participation	Ongoing	5%

NOTE:

- Evaluations will go towards 75% of your final grade with the best 3 of 4 evaluations contributing to the final grade.
- If you miss one evaluation, there will be no supplemental available to you.
- There will be material overlap between successive evaluations.
- Participation marks shall be awarded based upon class attendance as well as in-class engagement (including, but not limited to: the presence of a nametag, in-class questions / discussion), and e-mail etiquette

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 the final examination 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 2 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 3 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.
- 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.
- Not attending in-person course requirements due to potential COVID-19 symptoms is **not** sufficient on its own.

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.

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, so as to be clearly visible from a distance of 15 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. Examples of disruptive behaviour, depending upon the circumstances includes, but is not limited to:

- Late class arrival
- Disrespectful communication with Teaching Assistants, Colleagues, and Professor
- Side conversations during the lecture not related to course material
- Cell-phone usage / texting during lectures.

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.

KEY SESSIONAL DATES

Fall Term
Classes begin: September 8, 2022;
Fall Reading Week: October 31 – November 6, 2022;
Classes end: December 8, 2022;
Exam period: December 10 – 22

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.

Students that are in emotional/mental distress should refer to Mental Health@Western, **http://www.uwo.ca/uwocom/mentalhealth/**, for a complete list of options about how to obtain help.

ACADEMIC CONSIDERATION FOR STUDENT ABSENCE:

For Western University policy on Consideration for Student Absence, see http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_12

and for the Student Medical Certificate (SMC), see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

NOTICES:

Students are responsible for checking their Western email and notices posted on OWL (http://owl.uwo.ca) for news and updates. This is the primary method by which information will be disseminated to all students in the class.
If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

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.