MME 3374A - Electrical Foundations for Mechanical Engineers

COURSE OUTLINE – 2025-2026

CALENDAR DESCRIPTION:

MME 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:	Please consult "draftmyschedule"
Labs:	Please consult "draftmyschedule. Lab section assignments will be posted on OWL Brightspace in the second week of classes. Lab exercises will be in the form of: 1. Individual laboratory experiments including pre-lab simulation exercises using LTSpice 2. An in-person practical lab evaluation
Tutorials:	Please consult "draftmyschedule"

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.

PREREQUISITES:

Physics 1402 A/B

ANTIREQUISITES:

MSE 3302A/B, ECE 3374A/B.

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 MS Teams. 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 review principles regarding wire sizing and circuit protection. 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. The concept of power factor will be introduced along with VAR compensation. The theory of operation of transformers will be presented.

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:

- Relays and Switches
- Diodes
- Power MOSFETs
- 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 (brushless) 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 studied 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 analytical means and problem sets.

6. Thévenin and Norton equivalents / Validation of Systems Incorporating Electronics

Thévenin and Norton equivalent circuits will be studied in both AC and DC circuits. An overview of the way mechatronics systems are validated at the system level shall also 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:

The Mechanical and Materials Engineering Program has been accredited by Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. Accredited programs provide the academic requirements for licensure as a professional engineer in Canada. Western Engineering has defined indicators of the 12 Graduate Attributes (GAs) that the CEAB expects graduating engineering students to demonstrate. The connections between course learning outcomes and Western Engineering's GA Indicators are identified below.

Upon successful completion of this course, students will be able to:

- Understand voltage, current, and power relationships in passive components. KB3
- Understand electrical analogs for mechanical components. KB3
- Perform voltage, current and power calculations in DC and AC circuits. KB3
- Perform power factor calculations in single phase and three phase AC circuits. KB3
- Determine Thévenin and Norton equivalent circuits employing resistive and reactive components. KB3
- Simulate, construct, and analyze simple circuits used to condition physical signals. I3
- Understand the theory of operation of electromechanical and power electronic devices used in energy conversion. KB3
- Understand system level considerations in the application of systems incorporating power electronic devices. KB3
- Perform static and transient thermal modelling on assemblies containing power electronic devices. KB3
- Understand component derating and its importance on electronic device application. KB3

- Understand the system level influences on electronic device reliability. KB3
- Understand device failure modes and their system level implications. KB3
- Understand the theory of operation and construction of electric motors typically used in industry, including factors affecting efficiency. KB3
- Analyze mechanical systems incorporating electric motors. D3
- 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. KB3, I3
- Understand the processes used to manufacture electronics, along with typical quality issues that are associated with electronic manufacturing and packaging means. KB3

CONTACT HOURS: 3 lecture hours, 3 lab hours (labs are not weekly and are conducted according to a schedule), 2 tutorial hours, half course.

TEXTBOOK: Electrical Engineering – Principles and Applications – 7th Edition, Hambley, A.R., Pearson, 2018. The book is available in an electronic version through accessing the following link: https://bookstore.uwo.ca/textbook-search?campus=UWO&term=W2025A&courses%5B0%5D=001_UW/MME3374A

Hardcopies of the text are not to be used as we will be using the Mastering Engineering component of the electronic textbook.

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 LTSpice.

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 1	Friday, October 10	25%
Test 2	Friday, November 14	25%
Final exam	TBD During Fall Exam Period. Cumulative.	30%
Laboratory Sessions	2 practice labs worth 2% each according to a schedule. 1 individual practical lab test worth 12% according to schedule (Designated Assessment)	16%
Attendance and Classroom Demeanour	Ongoing. Attendance marks shall be awarded based upon class attendance, punctuality, attentiveness, engagement during class as well as e-mail etiquette.	4%

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

- Lab sessions will be held in-person.
- All labs are to be completed individually.
- All students are to attend their assigned lab session at their assigned lab stations **with no exceptions**. If you are caught attending a non-assigned lab session, or if you conduct the lab in your unassigned lab station, you will receive a mark of 0 for that lab.
- Components of the practice lab reports may be graded in-process. Hand-in components of the practice lab reports will be due at the end of the assigned lab session. No late submissions will be accepted.
- The practical lab session will be graded in person.
- 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 practice laboratory session **with** academic consideration.
- A mark of 0% will be assigned to students who have missed a laboratory session **without** academic consideration. The practical lab cannot be missed without the academic consideration. You will not receive academic consideration for the practical lab without proper documentation (Designated Assessment).
- 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

- To pass the course, you must have completed at least 2 of the Term Test 1, Term Test 2, and the Final Test.
- Failing to achieve an aggregate average of 50% in term 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.
- There will be material overlap between successive evaluations.
- Only non-programmable calculators will be allowed during tests.
- Formulas will be provided during 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.

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 test** will be offered to those who miss a term test with academic consideration. If you miss one test with academic consideration, there will be no supplemental available to you and the weight of the missing test will be transferred to the final exam.
- Students are required to contact the instructor of the course for any other circumstances.

- Not attending in-person course requirements due to potential symptoms (example: colds, flu or COVID-19) 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:

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:

- Arrive to class on time
- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Use your computer and/or laptop if possible (as opposed to a cell phone or tablet). Ideally, cell phones should be out of sight during lectures.
- Maintain focus on the class material during lectures.
- Use of the Internet for other than course related activities is discouraged.

Attendance will be taken during lectures, and will factor into your final course grade.

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.

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) Use of generative artificial intelligence (AI) tools /software/app is not acceptable in all graded aspects of this course.

General Faculty / University Policies

The Faculty of Engineering and Western University have overarching policies that prescribe how undergraduate courses should run. The course-specific policies described above should be considered *in addition to* those overarching policies, or as course-specific interpretations of them. In the event of contradictions or confusion between course-specific policies above and general Faculty / University policies, please contact your course instructor for clarification.

Western Engineering's undergraduate polices can be found by navigating to:
https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/policies.html

and then clicking the "*Engineering Undergraduate Policies framework*" link.