MME 3374A - Electrical Foundations for Mechanical Engineers

COURSE OUTLINE – 2024-2025

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:	See Draft My Schedule
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 3301 A/B, 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
- 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 (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 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 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 manner in which 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:

- 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. KB3
- Select the appropriate type and size of motor for a given application. KB3
- 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, 2 tutorial hours, half course.

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 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 11	20%
Test 2	Friday, November 8	20%
Final exam	TBD During Fall Exam Period. Cumulative.	35%
Tutorial Quizzes	Ongoing	5%
Laboratory Sessions	2 practice labs worth 3% each according to a schedule. 1 individual practical lab test worth 10% according to schedule	16%

Attendance and Classroom Demeanour	Ongoing. Attendance marks shall be awarded based upon class attendance, punctuality, attentiveness during class and 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 students are to attend their assigned lab sessions **with no exceptions**. If you are caught attending a non-assigned lab session, you will receive a mark of 0 for that lab.
- 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.
- 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.

Tutorial Tests, Term Tests and Final Examination

- You will be required to have completed 3 tutorial quizzes to pass the course. The tutorial quiz grades will be based upon your best 3 of 4 tutorial quiz marks.

- 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 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 tutorial quiz without academic consideration. For students who have missed a tutorial quiz with academic consideration, the tutorial grade component will be based upon the best 3 of 4 tutorial quiz marks.
- 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.

REPEATING STUDENTS:

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.

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)
- 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.

KEY SESSIONAL DATES

Fall Term

Classes begin:	September 5
Thanksgiving:	October 14
Fall Reading Week:	October 12 – October 20
Classes end:	December 6
Study days:	December 7-8
Exam period:	December 9 – 22

NOTICES:

Students are responsible for checking their Western email and notices posted on OWL/Brightspace (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/Brightspace site, they can seek support on the OWL/Brightspace Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

General Faculty / University Policies

In the event of contradictions between course-specific policies above and general Faculty / University policies described below, please contact your course instructor for clarification.

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 Associate Dean Academic (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean Academic, the student will be debarred from taking the regular examination in the course.

Missed/Late Accommodation Policy

1. Students missing a test/assignment/lab or examination you will report the absence by submitting an Academic Consideration Request form through STUDENT ABSENCE PORTAL.

2. **Documentation must be provided as soon as possible.**

Exam Accommodation

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (below for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.

3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an Academic Consideration Request Form through STUDENT ABSENCE PORTAL.

PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

Late Assignments

1. Advise the instructor if you are having problems completing the assignment on time (prior to the due date of the assignment).

2. Be prepared to submit the Academic Consideration Request Form and provide documentation if requested by the instructor (see below for information on documentation).

3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.

4. Some courses may have built-in flexibility for assignment deadlines or the total number of assignments that will be graded. See course-specific policies for details.

5. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

Medical Accommodation

1. The Academic Consideration Request Form is available through the STUDENT ABSENCE PORTAL.

2. Requests for academic consideration must include the following components:
   a. Indication of the course(s) and assessment(s) affected by the request
   b. Medical note, and
   c. Additional supporting documentation as relevant

3. Requests for academic consideration without a medical note or other supporting documentation may be accepted once per term, per course.

4. Undocumented absences cannot be used for examinations scheduled by the Office of the Registrar during official examination periods (including take-home final exams and December mid-year exams for full courses) and practical laboratory and performance tests typically scheduled in the last week of the term. Undocumented absences also cannot be used for the "designated assessment" in each course. When flexibility in assessment exists and is clearly stated on the course outline, both undocumented absences and academic consideration requests with documentation may be denied.

5. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**

6. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline.

   Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Registration.

7. An instructor may deny academic consideration for any assessment that is not required in the calculation of the final grade (e.g., "8 of 10 quizzes"). Assessment flexibility must be indicated on the course outline.

8. An instructor may deny academic consideration relating to the timeframe submission of work where there is already flexibility in the submission timeframe (e.g., 72-hour submission window). This assessment flexibility must be indicated on the course outline.

Religious Accommodation

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

Academic Integrity

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit Academic Integrity Western Engineering for more information

Academic Offences

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.
Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know

Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. 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.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Faculty of Engineering AI Policy

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials.

However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

Use of English Policy

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination 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.

Accessibility

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the Accessibility Western University for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit Academic Support & Engagement -Academic Accommodation.

Inclusivity, Diversity, and Respect

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the Office of Equity, Diversity and Inclusion.

Health and Well-Being

- Health & Wellness Services – Students - Offers appointment-based medical clinic for all registered part-time and full-time students.
- Mental Health Support - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- Crisis Support - For immediate assistant, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click here.
- Gender-Based Violence and Survivor Support - Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support

to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, here. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Links

- **WESTERN ACADEMIC CALENDAR**
- **ACADEMIC RIGHTS AND RESPONSIBILITIES**
- **ENGINEERING PROGRESSION REQUIREMENTS AND ACADEMIC REGULATIONS**
- **UNIVERSITY STUDENTS' COUNCIL (USC) - SERVICES**
- **IMPORTANT DATES AND DEADLINES**
- **ACADEMIC CONSIDERATION FOR MEDICAL ILLNESS - UNDERGRADUATE STUDENTS**
- **ACCOMMODATIONS FOR RELIGIOUS HOLIDAYS**
- **SCHEDULING OF ASSIGNMENTS, TESTS, AND EXAMINATIONS**
- **STUDENT FORMS**
- **OFFICE OF THE REGISTRAR**
- **RETENTION OF ELECTRONIC VERSION OF COURSE OUTLINES (SYLLABI)**
- **ACADEMIC APPEALS**
- **STUDENT ABSENCE PORTAL**

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Add Deadlines:

First term half course (i.e. "A" or "F")	September 13, 2024
Full courses and full-year half course (i.e. "E", "Y" or no suffix)	September 13, 2024
Second term half course (i.e. "B" or "G")	January 14, 2025

***Drop Deadlines*:**

First term half course without penalty (i.e. "A" or "F")	November 12, 2024
Full courses and full-year half courses without penalty (i.e. "E","Y" or no suffix)	December 2, 2024
Second term half or second term full course without penalty (i.e. "B" or "G")	March 7, 2025

Contact Information:

Undergraduate Services Office:	SEB 2097
Phone: 519-661-2130	E-mail: engugrad@uwo.ca
Mechanical Engineering:	SEB 3002
Phone: 519-661-4122	E-mail: mmeundergraduate@uwo.ca
Chemical & Green Process Engineering:	TEB 477
Phone: 519-661-2131	E-mail: cbeugrad@uwo.ca
Civil Engineering:	SEB 3005
Phone: 519-661-2139	E-mail: civil@uwo.ca
Computer, Electrical, Mechatronic Systems & Software Engineering	TEB 279
Phone: 519-661-3758	E-mail: eceugrad@uwo.ca
Integrated Engineering	ACEB 2410
Phone: 519-661-6725	E-mail: engceli@uwo.ca
Office of the Registrar/Student Central	WSSB 1120
Phone: 519-661-2100	