MME 3374A - Electrical Foundations for Mechanical Engineers

COURSE OUTLINE – 2023-2024

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

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 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 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 also 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:

- 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. 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:

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 hours, 2 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.

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.
- 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.
- 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 quiz** will be offered to those who miss a term test with academic consideration.
- 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.

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. If cheating during any course evaluation is suspected (including lab assignments), the student will receive a mark of zero for that particular evaluation. Please refer to the link below concerning policies regarding academic offences:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20

KEY SESSIONAL DATES

Fall Term

Classes begin:	September 7
Thanksgiving:	October 9
Fall Reading Week:	October 30 – November 5
Classes end:	December 8
Study day:	December 9
Exam period:	December 10 – 22

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.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

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.

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

A. *GENERAL REGULATIONS & PROCEDURES*

1. All first-year students will report to the Undergraduate Services Office by submitting the Academic Consideration Request Form, for all instances.

2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting Academic Consideration Request Form. Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.

3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.

4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.

5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. *TERM/MIDTERM TESTS*

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.

2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the Academic Consideration Request Form. If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the Undergraduate Services Office.

3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see next page for information on documentation).

4. Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.

C. *FINAL EXAMINATIONS*

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to report your absence using the Academic Consideration Request Form and request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page 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 "Application for a Special Exam" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

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

D. *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 reverse side 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. i) 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.
   ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

E. *SHORT ABSENCES*

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. *EXTENDED ABSENCES*

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. *DOCUMENTATION*

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

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

H. *ACADEMIC CONCERNS*

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**

3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

Calendar References: Check these regulations in your 2023 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness:
https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_135
Academic Accommodations for Students with Disabilities:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10
Academic Accommodations for Religious or Holy Days:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16
Course Withdrawals:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75
Examinations:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=
Scheduling of Term Assignments:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78
Scholastic Offences:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20
Student Medical Certificate:
https://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf
Engineering Academic Regulations:
http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86

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 15, 2023
	Full courses and full-year half course (i.e. “E”, “Y” or no suffix)	September 15, 2023
	Second term half course (i.e. “B” or “G”)	January 16, 2024
***Drop Deadlines*:**	First term half course without penalty (i.e. “A” or “F”)	November 13, 2023
	Full courses and full-year half courses without penalty (i.e. “E”,“Y” or no suffix)	November 30, 2023
	Second term half or second term full course without penalty (i.e. “B” or “G”)	March 7, 2024

Contact Information:

Undergraduate Services Office:	SEB 2097	Phone: 519-661-2130	E-mail: engugrad@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
Mechanical Engineering:	SEB 3002	Phone: 519-661-4122	E-mail: mmeundergraduate@uwo.ca