

Course Outline (F2023)

ELE746: Power Systems Analysis

Instructor(s)	Dr. Mohammadreza Arani [Coordinator] Office: ENG323 Phone: (416) 979-5000 x 556109 Email: marani@torontomu.ca Office Hours: Mondays 13:00 - 14:00, and Wednesdays 11:00 - 12:00
Calendar Description	Overview of the power system; Generator and transformer models and operation; Per-unit system of calculations; Transmission line parameters; Steady-state operation of short, medium-length, and long transmission lines; Load Flow problem and Gauss-Seidel and Newton-Raphson iterative methods of solution; Symmetrical fault analysis; Simulation of power systems using software packages.
Prerequisites	ELE 637 and ELE 639
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. Power System Analysis, H. Saadat, 3rd Edition, 2010, PSA Publishing: ISBN 9780984543809
Reference Text(s):	1. Power System Analysis and Design, 5th edition by J.Duncan Glover, Mulukutla S. Sarma and Thomas J. Overbye, published by Cengage learning, 2012.
Learning Objectives (Indicators)	<p>At the end of this course, the successful student will be able to:</p> <ol style="list-style-type: none"> 1. Use specialized core knowledge of electric circuits, electromagnetism, and electromechanical energy conversion devices to predict and understand behavior of a power system. (1d) 2. Use judgment in solving problems that have information uncertainties, and check for alternative models and solution techniques (2a) 3. Evaluate results through manual calculations and use of general-purpose and specialized software, to predict the performance and to determine the prediction closest to the reality. (5a) 4. Consider economic, social, and environmental factors in decision-making in designs, implementations and operations, and understand the impact of decisions and activities on the environment, and develop environmental-friendly sustainable power systems. (9a) <p>NOTE: Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).</p>
Course Organization	3.0 hours of lecture per week for 13 weeks 2.0 hours of lab per week for 12 weeks

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Teaching Assistants	Negar Karimipour Eren Alli																		
Course Evaluation	<table border="1"> <thead> <tr> <th colspan="2">Theory</th> </tr> </thead> <tbody> <tr> <td>Theory: Mid-term Examination</td> <td>20 %</td> </tr> <tr> <td>Theory: Final Examination</td> <td>35 %</td> </tr> <tr> <td>Theory: Quizzes</td> <td>10 %</td> </tr> <tr> <td>Theory: Reading Project</td> <td>5 %</td> </tr> <tr> <th colspan="2">Laboratory</th> </tr> <tr> <td>Lab: Two-bus single-phase network</td> <td>15 %</td> </tr> <tr> <td>Lab: Multi-bus three-phase network</td> <td>15 %</td> </tr> <tr> <td>TOTAL:</td> <td>100 %</td> </tr> </tbody> </table> <p>Note: In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both "Theory and Laboratory" components, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the "Course Evaluation" section above for details on the Theory and Laboratory components (if applicable).</p>	Theory		Theory: Mid-term Examination	20 %	Theory: Final Examination	35 %	Theory: Quizzes	10 %	Theory: Reading Project	5 %	Laboratory		Lab: Two-bus single-phase network	15 %	Lab: Multi-bus three-phase network	15 %	TOTAL:	100 %
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Examinations	Midterm exam in approximately Week 7 during regular class hours, two hours. Final exam, during exam period, three hours. Details will be announced in D2L																		
Other Evaluation Information	Two reports are required for the labs. In order to achieve a passing grade, the student must achieve an average of at least 50% in both theoretical and laboratory components. The reading project will also be assessed based on the delivered report. The reading project is a part of the theory component of the course.																		
Other Information	Quizzes will be held during lecture sessions. The exact time of quizzes will be announced on D2L.																		

Course Content

Week	Hours	Chapters / Section	Topic, description
1-2	6		Introduction fundamentals and conventions (Chapter 2) - Structure and components of the power system

			<ul style="list-style-type: none"> - Power in single-phase circuits - Real power reactive power and complex power - Power factor correction - Complex power flow and complex power balance - Balanced three-phase circuits - Per-phase analysis and graphical conventions - Delta-Y transformations - Power in three-phase circuits
3-4	6		<p>Models for short transmission lines generators and transformers (Chapters 3 and 4)</p> <ul style="list-style-type: none"> - Short transmission line model - Synchronous generator construction and model - Single-phase transformer model (equivalent circuit) - Transformer performance - Three-phase transformers - Per-unit system of calculations and change of base
5-6	6		<p>Transmission line models and performance (Chapter 5)</p> <ul style="list-style-type: none"> - Short-line model (review) - Medium-line model - Long-line model - ABCD parameters - Transmission line performance
7-8	6		<p>Analysis of balanced faults (Chapter 9)</p> <ul style="list-style-type: none"> - Balanced three-phase fault - Short-circuit capacity - Bus impedance matrix - Fault analysis using bus impedance matrix
9-10	6		<p>Power-flow analysis (Chapter 6)</p> <ul style="list-style-type: none"> - Bus admittance matrix and network calculations - Power-flow problem and equations - Gauss-Seidel method for solving power-flow equations - Newton-Raphson method for solving power-flow equations
11	3		<p>Symmetrical components and unbalanced faults (Chapter 10)</p> <ul style="list-style-type: none"> - Fundamental of symmetrical components - Sequence impedances - Fault analysis using sequence components
12	3		<p>Transmission line parameters (Chapter 4)</p> <ul style="list-style-type: none"> - Transmission line resistance

- Transmission line inductance
- Transmission line capacitance

Laboratory(L)/Tutorials(T)/Activity(A) Schedule

Week	L/T/A	Description
2	Tutorial 1 (Chapter 2)	Tutorials and Introduction
3	Tutorial 2 (Chapter 2)	Lab and Tutorials
4	Tutorial 3 (Chapter 3)	Quiz 1 (fundamentals)
5	Tutorial 4 (Chapter 3)	Quiz 2 (Chapter 2)
6	Tutorial 5 (Chapter 3)	Quiz 3 (Chapter 3)
8-9	Lab 1	Lab 1: Project 1
10-11	Lab 2	Lab 2: Project 2 (Lab 1 Report Due on Week 10)
12	Tutorial 6: Review	(Lab 2 Report Due on Week 12)

University Policies

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on [the Senate website](#)

Important Resources Available at Toronto Metropolitan University

- [The Library](#) provides research [workshops](#) and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the [Library's virtual research help service](#) to speak with a librarian.
- [Student Life and Learning Support](#) offers group-based and individual help with writing, math, study skills, and transition support, as well as [resources and checklists to support students as online learners](#).
- You can submit an [Academic Consideration Request](#) when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the [Senate website](#) and select the blue radio button on the top right hand side entitled: Academic Consideration Request (ACR) to submit this request.

For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences more than 3 days in duration and those that involve a final exam/final assessment, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate [Policy 167: Academic Consideration](#).

- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The [Remote Learning Guide](#) for students includes guides to completing quizzes or exams in D2L Brightspace, with or without [Respondus LockDown Browser and Monitor, using D2L Brightspace](#), joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for [Faculty](#) and [students](#).

Accessibility

- Similar to an [accessibility statement](#), use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).
- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about [Academic Accommodation Support](#).
- Learn [how to register with AAS](#).

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about [Academic Accommodations versus Academic Consideration and how to access each](#).

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:** 24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:** 24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via [My SSP app](#) or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca
- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the [Toronto Metropolitan University Mental Health and Wellbeing](#) website.