Western University
Faculty of Engineering
Department of Electrical & Computer Engineering

ECE 9408A (Ph.D., M.ESc.), ECE 9048A (M. Eng.)

Modeling Power Systems for Protection, Control, and Transients Studies

COURSE OUTLINE 2023-2024

Description:

This course provides the students with theoretical and practical knowledge of Power Systems modeling and time-domain simulation, which has significant applications in many areas including Power Systems Protection, Control, and Transients.

Enrollment Restrictions:

Enrollment in this course is restricted to graduate students in Power Systems, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

Course Format:

In person

Antirequisites:

None

Prerequisites:

ECE 4464A or equivalent

Textbook and Optional Course Readings:

There is no required textbook for the course. Course notes will be provided on the course website. Recommended references will be listed at the end of the course notes. Additional supplementary materials, e.g., relevant research papers, may be also posted on the course website or identified for download from the university library.

Topics:

Topic	Learning Activities	Tentative timeline
1. Principles of Modeling and Simulation • Introduction to time-domain simulation • Applications, advantages, and limitations of off-line time-domain simulation • Modeling linear and nonlinear components • Circuit discretization, integration methods, and numerical stability • Choosing a proper simulation time-step	Lectures Homework assignment Project	Weeks 1 and 2
2. power system main components • Transformers • Loads • breakers • Transmission lines • Arresters	Lectures Homework assignment Project	Weeks 3 and 4
3. Generation Systems • Synchronous generator, excitation systems, prime movers • Wind turbine-generators • Photovoltaic generation systems	Lectures Homework assignment Project	Weeks 5 - 7
4. Transients in power systems and network stability 1 • Low frequency oscillations • Mitigation methods (Power System Stabilizers PSS)	Lectures Homework assignment Project	Weeks 8 and 9
5. Transients in power systems and network stability 2 • Sub Synchronous Resonance • Sub Synchronous Controller Interaction (SSCI) for renewable generations • Mitigation methods and protection challenges	Lectures Homework assignment Project	Weeks 10 and 11

6. Very fast switching transients • Transient Recovery Voltage (TRV) • Lightning • Transient Over Voltage (TOV)	Lectures Homework assignment Project	Week 12

Specific Learning Outcomes:

Degree Level Expectation	Weight	Assessment Tool	Outcomes
Depth and breadth of knowledge	50%	• Homework assignments • Project	• Understanding of advanced concepts related to power system modeling and simulation • Awareness of important current problems in the field of power system modeling and simulation • Understanding of computational and/or empirical methodologies to model and simulate power systems
Application of knowledge	25%	• Homework assignments • Project	• Ability to apply knowledge of power system modeling in a rational way to analyze a particular problem • Ability to use coherent approach to develop power system models using PSCAD/EMTDC program.
Communication skills	10%	• Homework assignments • Project	• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively

Awareness of limits of knowledge	15%	• Homework assignments • Project	• Awareness of the need of assumptions in complex scientific analyses and their consequences • Understanding of the difference between theoretical and empirical approaches • Ability to acknowledge analytical limitation due to complexity of practical problems

Assessments:

Component	Material Covered	Weight (%)
Homework Assignments (six)	Topics 1 - 6	60
Project	Project topic to be decided later	40

Assignments:

The objective of the assignments is to reinforce the covered material and enable the students to use what they learn. There will be six assignments. Each assignment requires the students to develop a power system model and investigate a case study based on the provided instructions. The assignments may also include questions that evaluate the students' knowledge on the subjects covered in the lectures.

Project:

Students are required to complete a project that involves modeling, simulation, and analysis of a power system and investigate an issue/challenge (decided in consultation with the instructor). The project provides the students with an opportunity to experience some of the challenges that they may face in their future work/research activities. A list of several suggested project titles will be provided, and the students must choose one or submit their proposed subject before the reading week. The instructions for the content of the proposals and the project requirements will be provided on the course website.

The project reports should be prepared according to the IEEE PES conference paper format (templates are available on the IEEE PES website). The deadline for submission of the project reports is the end of the last lecture. The project presentations will be made during the last lecture. All presentation slides must be submitted the day before that meeting.

Activities in which collaboration is permitted:

The assignments must be solved individually. However, all students are highly encouraged to collaborate with each other in learning the course content and the PSCAD software. Besides, for the course project, the students can form groups of two students, collaborate with each other, and submit one report (encouraged but not necessary). The report submitted for each group project must include the names of all group members and a short description of each member's role/contributions.

Activities in which students must work alone (collaboration is not permitted):

The students are allowed to discuss general approaches to problems with each other. However, each student is expected to **independently** develop the requested models, perform studies, answer questions, and prepare/submit assignment reports. In other words, for the assignments, the students are **not allowed to share** any files, models, codes, or solutions with each other.

General:

A student who fails to obtain a passing grade in any of the aforementioned components (assignments or project) shall receive a final grade not greater than 48%.

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining 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 at the discretion of the course instructor.

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 with the exception of 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. In addition, in the professional life of an engineer, the manner in which oral and written communications are presented is extremely important. To encourage the student to do so, the grades assigned to all written and oral work will take into account all aspects of presentation including conciseness, organization, neatness, use of headings, and the preparation and use of tables and figures.

Assignments and Project Report Submission:

All assignments and project reports must be submitted online via OWL. Each report must be submitted as a single **PDF** file along with the corresponding models, e.g. PSCAD file(s) or MATLAB codes, that are needed to reproduce the reported results. The assignment reports must be organized based on the part numbers given in the assignment description. The files should not be compressed before submission. The PSCAD files and MATLAB codes (if applicable) should be properly named based on the associated assignment section. Students may be penalized up to 10% of the marks on the assignments and the project for not following these instructions.

All assignments and project reports are due by 23:55 on the due date. Late submissions will not be accepted. In case the assignment/report cannot be submitted through OWL (due to technical issues), the students can submit them by sending an email to the instructor AND the TA before the deadline.

CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

CONDUCT

Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

HEALTH/WELLNESS SERVICES

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Faculty of Engineering has a Student Wellness Counsellor. To schedule an appointment with the counsellor, contact Kristen Edwards (khunt29@uwo.ca) via confidential email and you will be contacted by our intake office within 48 hours to schedule an appointment.

Students who 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.

SICKNESS

Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at:
https://www.eng.uwo.ca/graduate/current-students/academic-support-andaccommodations/index.html

ACCESSIBLE EDUCATION WESTERN (AEW)

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program. Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW): http://academicsupport.uwo.ca/accessible_education/index.html

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.