Western University
Faculty of Engineering
Department of Electrical & Computer Engineering

ECE 9920

Microgrids: Fundamentals, Operation, and Applications

Summer 2026

Description:

This course introduces microgrids as the building blocks of the emerging smart grids and provides students with theoretical and practical knowledge of microgrid operation, control, energy management, stability, protection, modelling, and simulation.

Enrollment Restrictions:

Enrollment in this course is restricted to graduate students in Electrical Engineering, 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.

Instructor Contact Information:

Course instructor: Rana Hosseini
Email address: rhosse4@uwo.ca
Office: TBD
Office hours: By appointment
Contact hours: 4 hours per week (2 x 2-hour sessions)
Lecture hours: TBD

Course Format:

In-person

Antirequisites:

None

Prerequisites:

ECE 3333 or equivalent

Textbook and Optional Course Readings:

There is no required textbook for the course. Links to recommended textbooks that are available online will be provided on the course website. Additional supplementary materials, e.g., relevant research papers, will be posted on the course website or identified for download from the university library.

Recommended References:

H. Farhangi, G. Joós, distributor IEEE Xplore, and publisher Wiley, *Microgrid planning and design : a concise guide*, 1st ed. Hoboken, New Jersey: Wiley-IEEE Press, 2019. doi: 10.1002/9781119453550.

S. A. Roosa, Ed., *Fundamentals of microgrids : development and implementation*, First edition. Boca Raton, FL: CRC Press, 2022.

Y. R. Li, F. Nejabatkhah, and H. C. Tillman, *Smart hybrid AC/DC microgrids : power management, energy management, and power quality control*. Chichester, West Sussex: John Wiley & Sons Ltd., 2023.

Topics:

Topic	Learning Activities	Tentative timeline
1. Introduction to Microgrids ● Outages and blackouts ● Power system reliability and resiliency ● Definition of a microgrid ● Types of microgrids (AC, DC, and hybrid AC-DC) ● Applications, advantages, and limitations of microgrids	● Lectures ● Homework assignment ● Project	Week 1
2. Microgrid Operation ● Grid-connected operation ● Islanded operation ● Microgrid transitions (smooth islanding and reconnection) ● Black start	● Lectures ● Homework assignment ● Project	Week 2
3. Microgrid Control ● Microgrid control requirements ● Microgrid control architectures ● Hierarchical control of microgrids ● Grid-forming and grid-following control of converters	● Lectures ● Homework assignment ● Project	Weeks 3 and 4

4. Microgrid Energy Management ● Dispatch of distributed energy resources ● Optimal operation of microgrids ● Forecasting of renewable energy generation ● Scheduling energy storage systems ● Demand response	● Lectures ● Homework assignment ● Project	Weeks 6
5. Microgrid Stability and Protection Challenges ● Microgrid protection requirements and challenges ● Microgrid protection requirements and challenges	● Lectures ● Homework assignment ● Project	Weeks 7
6. Microgrid Modelling and Simulation ● Modelling distributed energy resources ● Modelling microgrid loads ● Modelling the host power system ● Time-domain simulation of microgrids	● Lectures ● Homework assignment ● Project	Weeks 8 and 9

Specific Learning Outcomes:

Degree Level Expectation	Weight	Assessment Tool	Outcomes
Depth and breadth of knowledge	50%	● Homework assignments ● Quizzes ● Project ● Final exam	● Understanding of fundamental concepts related to microgrids ● Awareness of microgrid advantages and challenges ● Understanding of microgrid control and operation requirements ● Understanding of the current technologies and strategies for control and energy management in microgrids.
Application of knowledge	10%	● Homework assignments ● Project	● Ability to model a microgrid for numerical analysis ● Ability to use a power system simulation software to analyze a microgrid behaviour under various operating conditions.
Communication skills	25%	● Homework assignments ● Project	● Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of the limits of knowledge	15%	● Homework assignments ● Quizzes ● Project	● Awareness of the need for assumptions in complex scientific analyses and their consequences ● Understanding of the difference between theoretical and empirical approaches ● Ability to acknowledge analytical limitations due to the complexity of practical problems

Assessments (M.Eng):

Component	Material Covered	Weight for M.Eng. students (%)	Weight for Ph.D. and M.ESc. students (%)
Homework Assignments	Topics 1 – 6	30	30
Quizzes	Topics 1 - 6	10	10
Project	Topic TBD	30	40
Final Exam	Topics 1 – 6	30	20

Assignments:

The objective of the assignments is to reinforce the covered material and enable the students to use what they learn. Each assignment requires the students to review assigned reading materials, conduct an additional literature review, investigate a case study based on the provided instructions, prepare a report based on their findings, and make a presentation in class. The assignments must be completed individually. However, all students are highly encouraged to collaborate with each other in learning the course content.

Quizzes:

Eight quizzes will be given and must be completed during the lectures. Student responses may be collected online (using iClicker or another tool) or on paper. Students may be requested to work in groups or individually. Only the 6 highest quiz marks will be counted towards the final grade. Due to this assessment flexibility, academic consideration will not be granted for missed quizzes. If students miss 2/8 quizzes, the remaining 6 quizzes will be used in the calculation of the final grade. If students miss more than 2 quizzes, they will receive a grade of zero on each missed quiz.

Project:

The project provides the students with an opportunity to experience some of the challenges that they may face in their future work/research activities. Students are required to complete a project that involves review of assigned materials and the relevant literature, investigating a case study, modelling and simulating a microgrid study system if applicable, writing a final report, and making a presentation. Project topics will be selected in consultation with the instructor. A list of several suggested project titles will be provided, and the students must choose one or submit their proposed subject. 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 48 hours before the project presentation day (date to be announced on OWL). All presentation slides must be submitted along with the project report.

Final Exam:

The final exam will be closed-book and will cover all subjects covered in the lectures. Only nonprogrammable calculators will be allowed. The final exam date will be announced on OWL.

General:

A student who fails to obtain a passing grade (60%) in the final exam or the project shall receive a final grade not greater than 58%.

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 (if applicable). All assignments and project reports are due by 23:55 on the due date. This course employs flexible deadlines for the assignments and the project report. Students are expected to submit the assignments and the project report by the deadlines indicated on the OWL course website. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 48 hours past the deadline without academic penalty. Submissions after that window 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 before the deadline.

Please note that because the submission deadlines for the assessments and the project report already include flexibility in the form of 48-hour submission window, the instructor reserves the right to deny academic consideration for assignments which are submitted following the end of the period of flexibility. If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.

When a student receives academic considerations or academic accommodations which overlap with the built-in flexibility of the assessment, the longest period of accommodation will determine the deadline. The built-in flexibility of the assessment should not be taken to extend any considerations or accommodations.

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.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western is committed to working to end gender-based and sexual violence on campus and in our community 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.

GENERAL INFORMATION ABOUT MISSED WORK

University policy on academic considerations are described *here*. This policy requires that all requests for academic considerations must be accompanied by a self-attestation. Further information about academic considerations, and information about submitting this self-attestation with your academic consideration request may be found *here*.

Please note that any academic considerations granted in this course will be determined by the instructor, in consultation with the academic advisors in your Faculty of Registration, in accordance with information presented in this course outline.