ELEC496

Advanced Electrical Energy Systems

S2 Day 2019

School of Engineering

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
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Thursday 12.00-14.00

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Credit points
3

Prerequisites
ELEC324 and ELEC395 and ELEC396

Corequisites

Co-badged status

Unit description
This unit develops advanced knowledge and skills necessary for designing, analysing, controlling and operating future energy systems containing a substantial proportion of renewable energy sources (i.e. intermittent and distributed generation), energy storage, and new types of loads such as electric vehicles, in "smart grids" monitored and coordinated by modern information and telecommunications technology. Topics covered include; smart grids and micro-grids in electrical energy systems, energy efficiency and energy management strategies (e.g. in energy storage subsystems, and in buildings), electricity network monitoring technologies (e.g. phasor measurement units, smart meters), the IEC61850 power equipment automation standard, electrical subsystems such as flexible AC transmission systems (FACTS), solid state transformers and smart inverters, etc. The choice and impact of telecommunication technologies on the control and security of energy infrastructure will be emphasised, together with economic considerations and the role and impact of electricity markets on electrical energy systems, e.g. in demand management, etc.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Explain the next-generation electricity networks and Identify the key elements of future energy systems.
Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.
Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.
Design and investigate the performance of future grids with distributed generation and energy storage systems

General Assessment Information

Conditions required to pass the unit: e. g.: Grading and passing requirement for unit

In order to pass this unit a student must obtain a mark of 50 or more for the unit (i.e. obtain a passing grade P/ CR/ D/ HD). For further details about grading, please refer below in the policies and procedures section.

Late submissions and Resubmissions

Late submissions will attract a penalty of 10/100, 10% marks per day. Extenuating circumstances will be considered upon lodgment of a formal notice of disruption of studies.

Resubmissions of work are not allowed.

Assessment Tasks

Name	Weighting	Hurdle	Due
Tutorial	10%	No	Week 4, Week 9
Laboratory	25%	No	At the end of the laboratory task
Project	25%	No	Monday-Week 13
Final exam (closed book)	40%	No	During central exam period

Tutorial

Due: **Week 4, Week 9**
Weighting: **10%**

There are 12 tutorial sessions throughout the semester. **There is no tutorial session in week 1.** Each tutorial will have several problem-solving questions. A few questions will be solved interactively by the lecturer in the scheduled tutorial class. In each session, students will be asked to solve a question individually related to ones they have practiced on that session. The problems will be designed to enhance students' understanding of the topics covered in lectures and provide them with an opportunity to apply the knowledge they have learned from lectures to solving practical problems. There are also two in-tutorial tests in week 6 and week 12 respectively to test students' learning achievements at different stages of the course. The marks of the test will be counted towards the weighting of tutorial. In the tutorial class, the students will: (i) analyze the differences between past and future energy systems and depict the blueprint of future energy systems and (ii) identify, formulate and provide technical solutions to emerging problems related to renewable energy sources, energy storage, microgrid, data and communications in future energy systems.

On successful completion you will be able to:

- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.

Laboratory

Due: **At the end of the laboratory task**
Weighting: **25%**

There are 12 laboratory sessions throughout the semester. **There is no laboratory session in week 1.** The laboratories are strongly recommended; attendance, participation, and completion of all the laboratory activities are required in order to satisfactorily complete the course. Each laboratory task can take 2-3 weeks to complete depending on the workload. You are required to record all the laboratory scripts, results and printouts, answer all questions and submit them all in the form of a report by the end of the final scheduled week of each laboratory task. Completion of a laboratory activity is determined by having the laboratory tutor sign off the student log book, nominally during the laboratory sessions.

On successful completion you will be able to:

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Design and investigate the performance of future grids with distributed generation and energy storage systems

Project

Due: **Monday-Week 13**
Weighting: **25%**

A scenario-based project will be introduced in this course for the students to gain knowledge and skills by investigating and responding to an engaging challenge. The scenario to be studied in the project will be available on iLearn on or before the end of Week 3. The aim of Project is to work on the solution to a problem both analytically and via software implementation, and students are expected to work on the project throughout the course. There are two assessment items involved. One assessment is a presentation to be given during week 12 tutorial and laboratory sessions. The other assessment is a report that summarizes the project works and the associate findings. Each item accounts for half of the weighting of Project. All the project materials are required to be packed in a folder which should be submitted by the end of Week 13.

On successful completion you will be able to:

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- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.
- Design and investigate the performance of future grids with distributed generation and energy storage systems

Final exam (closed book)

Due: **During central exam period**
Weighting: **40%**

Final exam will cover all of the course content. This will be a closed book exam, and involve short answers and problem solving.

On successful completion you will be able to:

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.

- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.

Delivery and Resources

Lecture materials, Tutorial Questions, Laboratory Instruction Manuals, and Tutorial and Laboratory Solutions will be uploaded to iLearn.

Lectures will be recorded on Echo Recordings.

There are no prescribed textbooks for this course and ELEC496 lecture notes are the recommended readings.

The following references will each cover parts of the course only. Reading on them is encouraged.

- J. Ekanayake, K. Liyanage, J.Wu, A. Yokoyama, and N. Jenkins, *Smart Grid: Technology and Applications*, Wiley, 2012.
- J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Wiley, IEEE Press, 2012.
- A. F. Zobaa, and R. C. Bansal, *Handbook of Renewable Energy Technology*. World Scientific, 2011.
- N. Hatziargyriou, H. Asano, R. Iravani, and C. Marnay, “Microgrids”, *IEEE Power and Energy Magazine*, Vol.: 5, No: 4, pp. 78-94, 2007.
- H. Gharavi, and R. Ghafurian, “Smart Grid: The Electric Energy System of the Future [Scanning the Issue]”, *Proceedings of the IEEE*, Vol: 99, No: 6, pp. 917-921, 2011.
- F. Bouhafs, M. Mackay, and M. Merabti, “Links to the Future: Communication Requirements and Challenges in the Smart Grid”, *IEEE Power and Energy Magazine*, Vol: 10, No: 1, pp. 24-32, 2012.

Unit Schedule

For details, please refer to the Unit Schedule on the ELEC496 iLearn webpage.

Learning and Teaching Activities

Unit Schedule

Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together with relevant sections of the text and references.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.

Assessment tasks

- Laboratory
- Project
- Final exam (closed book)

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcome

- Design and investigate the performance of future grids with distributed generation and energy storage systems

Assessment tasks

- Laboratory
- Project

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.

Assessment tasks

- Laboratory
- Project

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where

relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcome

- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.

Assessment tasks

- Tutorial
- Final exam (closed book)

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.
- Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.

Assessment tasks

- Tutorial
- Final exam (closed book)

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .

Assessment tasks

- Tutorial
- Project
- Final exam (closed book)

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Analyse the new roles of electricity providers and consumers and envisage potential business and market opportunities in future energy systems.

Assessment tasks

- Laboratory
- Project
- Final exam (closed book)

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

- Explain the next-generation electricity networks and Identify the key elements of future energy systems.
- Demonstrate engineering knowledge and skills to handle renewable energy generation, energy storage, new loads, data and communications for future energy systems.
- Identify, formulate and provide solutions to the emerging problems in future energy systems coupled with Information and communications technology .
- Design and investigate the performance of future grids with distributed generation and energy storage systems

Assessment tasks

- Laboratory
- Project

Changes from Previous Offering

This is a new unit and offering first time in S2 2019.