School of Electrical Engineering and Telecommunications

Term 2, 2019
Course Outline

ELEC 3105
Electrical Energy

COURSE STAFF

Course Convener: Dr. Rukmi Dutta, Room EE406, (EET building), rukmi.dutta@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, after the lecture class times in the first instance, rather than via email. If you choose to make email enquiries, **all emails** should be made from your student email address with ELEC3105 in the subject line; otherwise they may not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

COURSE SUMMARY

Contact Hours

The course consists of 4 hours of lectures, a 3-hour laboratory session and 1-2 hours tutorials in each week. Tutorial will start from week 3*. Note that there are 2 hours tutorials in first few weeks followed by 1-hour tutorials in the later weeks. It is important to check your timetable carefully for these timeslots. The labs will start from week 4 and continue till week 10.

Lectures	**Day**	**Time**	**Location**
	Wednesday	2 pm – 4 pm	Colombo ThA
	Thursday	9 am – 11am	CLB 8
Tutorials*	Monday	9 am– 11 am (wk 3,4,5) 10 am – 11 am (wk 6,7,8,9,10,11)	RC Theatre
	Tuesday	9 am– 11 am (wk 3,4,5) 9 am – 10 am (wk 6,7,8,9,10 ,11)	RC Theatre
Laboratory	Time slots as per your time-table (wk 4 -10)		EE115

* Public holiday on Monday, week 2. Hence, tutorial for both groups starts from week 3 and continues to week 11.

Context and Aims

Develop understanding of the fundamental principles and performances of the circuit and devices associated with generation, transmission, distribution and utilization of electrical energy and to assist students to gain in depth knowledge about analysis and design of these circuits and devices.

Indicative Lecture schedule

Period	Summary of Lecture Program	
Week 1	Topic 0: Course introduction Topic 1: Introduction to Energy System	-
Week 2	Topic 2: Magnetic circuits Topic 3: Balanced Three-phase AC circuits	
Week 3	Topic 3: Balanced Three-phase AC circuits **(Tutorial starts)** Topic 4: Transformers	Tutorial 1
Week 4	Topic 4: Transformers **(Lab starts)**	Tutorial 2
Week 5	**Mid-Term Exam** Topic 5: Electrical Energy Conversion and DC machine	Tutorial 2
Week 6	Topic 5: Electrical Energy Conversion Topic 6: DC machine	Tutorial 3
Week 7	Topic 6: DC machine Topic 7: The induction machine	Tutorial 3
Week 8	Topic 7: The induction machine **(Assignment release)**	Tutorial 4
Week 9	Topic 7: The induction machine Topic 8: The synchronous machine	Tutorial 4
Week 10	Topic 8: The synchronous machine	Tutorial 5
Week 11	**(Assignment due)**	Tutorial 5

Assessment

Laboratory Practical Experiments	20%
On-line Quizzes	5%
Mid-Term Exam	15%
Assignment	10%
Final Exam (2 hours)	50%

There will be opportunities to win bonus marks through class room and tutorial activities. You may have to pass the final exam to pass the course.

COURSE DETAILS

Credits

The course is a 6 UoC course; expected workload is 10–12 hours per week throughout the 12-week semester.

Relationship to Other Courses

The course is a third-year core elective for students following a BE and BE/ME(Electrical) in the School of Electrical Engineering and Telecommunications at UNSW, Australia.

Pre-requisites and Assumed Knowledge

The pre-requisites for this course are ELEC2134, Circuits and Signals, ELEC3115, Electromagnetic Engineering. It is essential that students are familiar with basic circuit theory and electromagnetics.

Following Courses

The course is a pre-requisite for all professional electives in the energy system group at the School of Electrical Engineering.

Learning outcomes

After successful completion of this course, you should be able to:

1. Be able to analyse single and three phase AC circuits
2. Be able to know the working principle, and to analyse steady state performances of some important power engineering devices such as transformer, DC machine, Induction machine and Synchronous machine.
3. Be capable of selecting and designing these devices for real-life applications by applying underlying theories and concepts, recognize and evaluate the practical limitations and aspects of these devices.
4. Have gained practical experience in the performance and operation of these important power engineering devices and circuits through laboratory experiments.

This course is designed to provide the above learning outcomes which arise from the targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

Topics	Tutorials	Labs
Topic1: Introduction to Energy Systems • Overview of power generation • Energy resources: fossil and renewable (Emphasis on photovoltaic and wind energy conversion)	Tutorial 1	-
Topic 2: A Brief Review of Magnetic Circuits • Model of magnetic circuit • Magnetizing current • Losses in a magnetic circuit • Permanent magnet	Tutorial 1	-
Topic 3: Three-phase AC circuits • Introduction to three-phase AC systems • Wye-Delta connections • Phase and Line quantities • Balanced three-phase circuits • Wye-Delta transformation • Power in balanced three-phase system	Tutorial 2	Lab 1
Topic 4: Transformers • Ideal transformer • Impedance transformation • Practical or non-ideal transformer • Equivalent circuit and parameters • Per Unit (PU) calculation • Auto-transformer • Three- phase transformer	Tutorial 2	Lab 2
Topic 5: Electrical Energy Conversion • Principles of energy conversion, • Energy and co-energy • Force and torque calculations in electromechanical system • Rotational system - EMF and Torque calculations • Torque –speed characteristics of DC motors • Concept of self- excitation	Tutorial 3	-
Topic 6: The DC Machine (DM) • Introduction to DC machines and construction features • Torque and induced voltage equations	Tutorial 3	Lab 3

Topics	Tutorials	Labs
• Brush-commutation • Armature reaction • Type of DC machines and their performances		
Topic 7: The induction machine (IM) • Working principle – rotating magnetic field • Synchronous speed and slip • Induced voltages in stator and rotor • Equivalent circuit and parameter measurements • Motoring and generating operations • Stator current and Power factor • Torque-speed characteristics • Single-phase induction motors	Tutorial 4	Lab 4
Topic 8: The synchronous machine (SM) • Working principle • Induced voltage and synchronous speed • Generation and motoring operations • Equivalent circuit and parameters • Phasor diagrams of various operation and their applications • Physical meaning of load angle • Power and torque calculations • Salient pole type SM.	Tutorial 5	Lab 5

Students must revise the following materials from the prerequisite courses:
From ELEC 2134 (Circuits and Signals)
Fundamentals of AC Sinusoids – frequency, time period, phase angle, Concept of leading and lagging, phasor representation and phasor diagram, complex number algebra, impedance and admittance, equivalent impedance of series and parallel combinations.
AC circuit analysis and theorems – current/voltage divisions, Thevenin's theorem, superposition theorem, maximum power transfer theorem.

From ELEC3105(Electromagnetics)
Magnetic field, magnetic flux density, flux intensity, permeability, reluctance
Faraday's law, Ampere's law, hysteresis loop, Eddy current, BH graph.

TEACHING STRATEGIES

Delivery

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding; Active learning is encouraged in this course strongly.
- Tutorials, which allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material;
- Laboratory sessions, which support the formal lecture material and provide you with practical hand-on experience, measurement and debugging skills;
- Short periodic quizzes (with low weighing on assessment) provide feedback on the progress in learning.
- Participation and engagement to the course contents are strongly encouraged through classroom and tutorial activities.

Learning in this course

You are expected to attend all lectures, tutorials, labs, and mid-term exam in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed. In addition to the lecture notes/video/screencast, you should read relevant sections of the recommended textbooks. Reading additional texts will further enhance your learning experience. Group learning is also encouraged. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

Tutorial classes

You should attempt all tutorial sheet questions in advance of attending the tutorial classes. The importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Solutions of the tutorials will be released in the Moodle progressively. The tutor may discuss the more complex questions in the tutorial class. Solutions discussed in the tutorial classes may not be available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

Note there will be opportunities to earn bonus marks on various activities during the tutorial and lecture time.

Laboratory program

The laboratory program is an integral part of this course. The aim of the laboratory component is to ground the analytical subject material in a practical problem, meaning that the skills and knowledge you learn throughout the course will be applied in real engineering work.
You are required to attend all relevant laboratory classes. Laboratory attendance WILL be kept. Ample preparation prior to each laboratory class is paramount, as you will be doing some experiments before you learn the theory contents in the lectures.

The laboratory syllabus covers 5 experiments:

Experiment 1: Balanced Three-Phase Circuits.

Experiment 2: The Power Transformer.

Experiment 3: The DC Motor.

Experiment 4: The Three-Phase Induction Motor.

Experiment 5: The Synchronous Machine.

Because of the heavy pressure on laboratory resources, time and personnel, it will be very difficult for the School to reschedule laboratories once missed. The laboratory timetable and schedule produced by the timetabling division will therefore be followed strictly.

LATE ENTRY BY MORE THAN 15 MINUTES INTO THE LABORATORY WILL NOT BE PERMISSIBLE.

If you are late by more than 15 minutes, you will not be able to finish an experiment during the schedule time of 3 hours.
You are advised to read the *General Instructions for Laboratory* carefully before coming to the laboratory for the first time.

Laboratory Exemption

The students repeating this course are eligible for laboratory exemption. In order to get permission for exemption, you must submit laboratory exemption request form by **Friday of week 1**. Late submission of the form after this date will not be considered and lab exemption may not be granted.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Ongoing assessment occurs through the lab checkpoints, on-line quizzes, assignment and the mid-semester exam.

Laboratory Assessment

Laboratories are primarily about learning, and the laboratory assessment is designed mainly to check your knowledge as you progress through each stage of the laboratory tasks. You are required to **maintain a lab book** for recording your observations. A lab book is an A4 size notebook containing a mix of plain pages and graph sheets. You must have your own lab book to record your test results. Presentation of results in loose sheets or in mobile devices are strictly not allowed.
It is essential that you complete the laboratory preparation before coming to the lab. You will be recording your observations/readings in your lab book.
Your notes, experimental results, graphs produced using measured data recorded in the lab book and your verbal explanation of the results will be examined by the demonstrators at the end of each laboratory period. The lab demonstrator will sign your lab book after the assessment which will be used as a record of your lab marks, if necessary.
Assessment marks will be awarded according to your preparation i.e. readiness for the lab in terms of pre-reading, how much of the lab you were able to complete, your understanding of the experiments conducted during the lab, the quality of the measurements, graphs produced from the set of measured data, and your understanding of the topic covered by the lab.

Note that many of you will be doing labs before its theory contents are covered in the lectures. This way, you learn the practical side of the contents before the theoretical aspects. However, pre-reading of the theories provided in the laboratory sheets is essential to understand the fundamentals behind each lab.

A lab roster will be released before your first lab, if you want to work with a particular partner, please inform us by Friday of week 2.

Mid-Term Exam

The mid-term examination tests your general understanding of the course material and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any course material up to the end of week 4. It will contain numerical and analytical questions. Marks will be assigned according to the correctness of the responses using appropriate marking criteria.

Date: Wednesday, **03 July (Week 5)**, 2:00 pm-4:00 pm, Location: TBA.

Course materials: The test will be on lecture materials covered from **week 1 to week 4**.

If for medical reasons you are unable to attempt the tests, you must provide a valid medical certificate according to UNSW special consideration policy.

Assignment

The assignment allows self-directed study leading to the solution of partly structured problems. Marks will be assigned according to how completely and accurately the problems have been addressed, how well the relevant information is communicated, application of critical thinking while identifying assumptions, conclusions and implications and overall understanding of the course material demonstrated by the assignment report.

Information about the assignment and marking criteria will be released on week 8 and the last date of the assignment submission is **11:59 pm, Monday, 12 August (Week 11).** Submission will be via Moodle course page and **no late submission will be possible once the submission deadline passes.**

Online feedback quizzes

At the end of each topic, an online review quiz will be released, which students can complete on their own time, consulting lecture notes and books if necessary. These quizzes will give you feedback on how you are doing in the topics. Only the first attempt of the quizzes will be graded and contribute 5% towards your final marks. The main purpose of these quizzes is not assessment but rather to provide you with a feedback on how well you have understood the topics.

Final Exam

The exam in this course is a standard closed-book 2-hour written examination, comprising compulsory questions. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course (including laboratory), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes					
Assessment	**1**	**2**	**3**	**4**	**5**	**6**
Laboratory practical assessments	✓	✓	✓	✓	-	✓
Mid-semester exam	✓	✓	✓	✓	✓	-
Assignment	✓	✓	✓	-	✓	-
Final exam	✓	✓	✓	✓	✓	-

COURSE RESOURCES

Textbooks

The following text books may help in learning the topics in-depth:

1. Electrical Machinery Fundamentals (*prescribed*) Author: Stephen J. Chapman (fourth edition) Publisher: McGraw Hill
2. Principles of Electric Machines and Power Electronics (2nd ed, *prescribed*) Author: P. C. Sen Publisher: John Wiley and Sons
3. Electromechanics and Electrical Machinery, Authors: J. F. Lindsay and M. H. Rashid Publisher: Prentice-Hall
4. Electric Machines and Power Systems Author: V. D. Toro Publisher: Prentice-Hall

Further Reading

The following books may be consulted for further reading by those who really want to explore further.

1. Alternating Current Machines by M. G. Say
2. Electric Machines and Drives by G. R. Slemon
3. Analysis of Electric Machinery by Paul Krause

You may also refer to online academic skills resources page for general guidance on study skills:

http://www.lc.unsw.edu.au/olib.html

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

OTHER MATTERS

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application prior to the start of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the "fit to sit/submit" rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the the online student survey myExperience. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

For example weekly tutorial format was adopted based on past students' feedback. A laboratory roster for individual student was adopted based on a feedback from previous students.

In previous years, students' overall satisfaction soars up to 95% for this course. It became possible only because of on-going improvement made to the course based on students' constructive feedbacks.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

APPENDICES

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;

- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Attributes

The course delivery methods and course content addresses a number of core UNSW graduate attributes, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and take-home assignment and final exam.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

	Program Intended Learning Outcomes	
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	✓
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	✓
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓
	PE1.4 Discernment of knowledge development and research directions	
	PE1.5 Knowledge of engineering design practice	✓
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice	
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving	✓
	PE2.2 Fluent application of engineering techniques, tools and resources	✓
	PE2.3 Application of systematic engineering synthesis and design processes	
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability	
	PE3.2 Effective oral and written communication (professional and lay domains)	✓
	PE3.3 Creative, innovative and pro-active demeanour	✓
	PE3.4 Professional use and management of information	✓
	PE3.5 Orderly management of self, and professional conduct	
	PE3.6 Effective team membership and team leadership	✓