UNSW Course Outline

ELEC3105 Electrical Energy - 2024

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General Course Information

Course Code : ELEC3105
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Energy plays a critical role in our everyday lives. Electrical energy (or electricity) is both a basic part of nature and one of the most widely used forms of energy. Electricity is a secondary energy source. It is produced through the conversion of primary energy sources such as coal, hydro, natural gas, nuclear, solar, and wind into electrical energy. Electricity is also a critical energy

carrier, facilitating both the transfer of energy and conversion to other forms, such as mechanical, chemical, etc.

For long, energy and electricity have been linked to economic growth and increase of energy consumption is linked to increase in GDP. In fact, a 1% increase in electricity consumption leads to approximately 1.5% increase in economic growth. A substantial portion (≈50%) of electricity globally is consumed in applications involving electric machines and motors. This increases to over 80% in industrial applications and will further increase primarily driven by electrification of transportation.

However, the landscape is currently changing. As economies move towards greener generation and more efficient electricity consumption, the challenge ahead lies in the decoupling between rates of economic growth and energy demand and fundamentally shifting the way we think about energy. Our goal in this course is to explore all aspects of electrical energy, from generation to consumption and introduce some of the most common and key components of the electrical network!

The course content includes Electrical energy supply systems; Transmission and Distribution systems; Energy Conversion; Generation of electrical energy; Utilisation of electrical energy; Thermal energy; Renewable Energy; Wind Energy; Solar Energy; Energy efficiency; Environmental aspects of Energy; Phasors; leading/lagging; Power; Power factor; Active Power; Reactive Power; Transformers; Equivalent circuits; single-phase transformers; Three-phase transformers; Delta connections; Star connections; Harmonics; DC machines; Induction machines; Synchronous machines.

Course Aims

The overarching aim of the course is to allow students to develop an understanding of the fundamental principles and performance of devices / components that are associated with Generation, Transmission, Distribution and Utilisation of Electrical energy and to assist students to gain an in-depth knowledge about analysis and design of these circuits and devices

Specifically, the aims of the course are to:

- Provide an Overview of Energy Systems.
- Introduce three-phase theory with balanced three-phase AC circuits.
- Analyse Power Transformers in Electrical Systems.
- Provide an overview of Energy Conversion in DC Machines, Induction, and Synchronous Machines.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Analyse single and three phase AC circuits
CLO2 : Explain the working principle including the steady-state performances of important power engineering devices such as transformers, DC machines, induction machines, synchronous machines.
CLO3 : Implement specifications for transformers, DC machines, induction machines and synchronous machines for real-life applications by applying underlying theories and concepts, recognizing and evaluating the practical limitations and aspects of these devices.
CLO4 : Gain practical experience in the performance and operation of these important power engineering devices and circuits through laboratory experiments.

Course Learning Outcomes	Assessment Item
CLO1 : Analyse single and three phase AC circuits	• Assignment • Final Exam • Laboratory Practical Experiments • On-line Quizzes
CLO2 : Explain the working principle including the steady-state performances of important power engineering devices such as transformers, DC machines, induction machines, synchronous machines.	• Assignment • Final Exam • Laboratory Practical Experiments • On-line Quizzes
CLO3 : Implement specifications for transformers, DC machines, induction machines and synchronous machines for real-life applications by applying underlying theories and concepts, recognizing and evaluating the practical limitations and aspects of these devices.	• Assignment • Final Exam • Laboratory Practical Experiments • On-line Quizzes
CLO4 : Gain practical experience in the performance and operation of these important power engineering devices and circuits through laboratory experiments.	• Laboratory Practical Experiments

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Learning and Teaching in this course

You are expected to complete suggested tasks of all lectures, tutorials, labs, and quizzes in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be

assessed by oral exam. 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 classes throughout the course.

Other Professional Outcomes

The Course Learning Outcomes (CLOs) contribute to the Engineers Australia (National Accreditation Body) Stage I competencies as outlined below

Engineers Australia (EA), Professional Engineer Stage 1 Competencies

PE1: Knowledge and Skill Base:
PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLO 1, 2, 3, 4,
PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: CLO 1, 2, 3, 4,
PE1.3 In-depth understanding of specialist bodies of knowledge: CLO 1, 2, 3, 4
PE1.4 Discernment of knowledge development and research directions: n/a
PE1.5 Knowledge of engineering design practice: CLO 1, 2, 3, 4,
PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice: n/a

PE2: Engineering Application Ability:
PE2.1 Application of established engineering methods to complex problem solving: CLO 1, 2, 3, 4,
PE2.2 Fluent application of engineering techniques, tools and resources: CLO 1, 2, 3, 4,
PE2.3 Application of systematic engineering synthesis and design processes: n/a
PE2.4 Application of systematic approaches to the conduct and management of engineering projects: n/a

PE3: Professional and Personal Attributes:
PE3.1 Ethical conduct and professional accountability: CLO 1, 2, 3, 4,
PE3.2 Effective oral and written communication (professional and lay domains): CLO 1, 2, 3, 4,
PE3.3 Creative, innovative and pro-active demeanour: CLO 1, 2, 3, 4,
PE3.4 Professional use and management of information: CLO 1, 2, 3, 4,
PE3.5 Orderly management of self, and professional conduct: n/a
PE3.6 Effective team membership and team leadership: CLO 1, 2, 3, 4,

This course is also designed to provide the course learning outcomes which arise from targeted

graduate capabilities. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (also listed below).

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

UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, 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 interactive checkpoint assessments and lab exams during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.
- Developing citizens who can apply their discipline in other contexts, are culturally aware and environmentally responsible, through interdisciplinary tasks, seminars and group activities

Additional Course Information

PLEASE REFER TO THE PDF VERSION OF THE COURSE OUTLINE.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment Assessment Format: Individual Short Extension: Yes (2 days)	18%	
Final Exam Assessment Format: Individual	55%	
Laboratory Practical Experiments Assessment Format: Individual	15%	
On-line Quizzes Assessment Format: Individual	12%	Start Date: Not Applicable

Assessment Details

Assignment

Assessment Overview

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.

Course Learning Outcomes

- CLO1 : Analyse single and three phase AC circuits
- CLO2 : Explain the working principle including the steady-state performances of important power engineering devices such as transformers, DC machines, induction machines, synchronous machines.
- CLO3 : Implement specifications for transformers, DC machines, induction machines and synchronous machines for real-life applications by applying underlying theories and concepts, recognizing and evaluating the practical limitations and aspects of these devices.

Detailed Assessment Description

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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.

Final Exam

Assessment Overview

The exam in this course is a standard two-hour written examination, comprising compulsory questions. The examination tests analytical and critical thinking and general understanding of the course material. 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.

Course Learning Outcomes

- CLO1 : Analyse single and three phase AC circuits
- CLO2 : Explain the working principle including the steady-state performances of important power engineering devices such as transformers, DC machines, induction machines, synchronous machines.
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Detailed Assessment Description

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examination tests analytical and critical thinking and general understanding of the course material. 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.

Laboratory Practical Experiments

Assessment Overview

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. 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.

Course Learning Outcomes

- CLO1 : Analyse single and three phase AC circuits
- CLO2 : Explain the working principle including the steady-state performances of important power engineering devices such as transformers, DC machines, induction machines, synchronous machines.
- CLO3 : Implement specifications for transformers, DC machines, induction machines and synchronous machines for real-life applications by applying underlying theories and concepts, recognizing and evaluating the practical limitations and aspects of these devices.
- CLO4 : Gain practical experience in the performance and operation of these important power engineering devices and circuits through laboratory experiments.

Detailed Assessment Description

Laboratory Assessment

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. 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.

On-line Quizzes

Assessment Overview

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 is graded.

Course Learning Outcomes

- CLO1 : Analyse single and three phase AC circuits
- CLO2 : Explain the working principle including the steady-state performances of important power engineering devices such as transformers, DC machines, induction machines, synchronous machines.
- CLO3 : Implement specifications for transformers, DC machines, induction machines and

synchronous machines for real-life applications by applying underlying theories and concepts, recognizing and evaluating the practical limitations and aspects of these devices.

Detailed Assessment Description

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. The highest mark of the quizzes will be the one counted in your marks.

General Assessment Information

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

Brief Assessment Description

1. Laboratory Practical Experiments: 15%
2. On-line Quizzes: 12%
3. Assignment: 18%
4. Final Exam (2 hours): 55%

You are expected to attend all labs and also make use of the open-lab hours of the course in order to maximize learning. It is important to prepare in advance of attending the laboratories each week; this includes preparing your own simulations and results. In addition to the lecture notes, you should read relevant sections of the recommended textbooks, articles and other provided material. Reading additional texts would further enhance your learning experience. Group learning is strongly encouraged.

Grading Basis

Standard

Requirements to pass course

50%

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Topic 1: Introduction to Energy Systems 1. Overview of power generation 2. Energy resources: fossil and renewable 3. Emphasis on photovoltaic and wind energy conversion
Week 2 : 3 June - 9 June	Lecture	Topic 2: Balanced Three-phase AC circuits 1. Introduction to three-phase AC systems, 2. Wye-Delta connections, 3. Phase and Line quantities, 4. Balanced three-phase circuits, 5. Wye-Delta transformation, 6. Power in a balanced three-phase system
Week 3 : 10 June - 16 June	Lecture	Topic 3: Transformers 1. Ideal transformer, 2. Impedance transformation, 3. Practical or non-ideal transformer, 4. Equivalent circuit and parameters
Week 4 : 17 June - 23 June	Lecture	Topic 3: Transformers 1. Per Unit (PU) calculations 2. Auto-transformers and instrument transformers 3. Three-phase transformers
Week 5 : 24 June - 30 June	Lecture	Topic 4: Electrical Energy Conversion and DC Machines 1. Principles of energy conversion- energy and co-energy 2. Force and torque calculations in the electromechanical systems 3. Introduction to DC machines and construction features, 4. Brush-commutation and armature reaction, torque and EMF calculation 5. Type of DC machines and equivalent circuits, equations 6. Torque – speed characteristics of DC motors 7. Concept of self- excitation in DC generators
Week 6 : 1 July - 7 July	Other	FLEXIBILITY WEEK
Week 7 : 8 July - 14 July	Lecture	Topic 5: The Induction Machine 1. Working principle – rotating magnetic field, 2. Synchronous speed and slip, 3. Induced voltages in stator and rotor 4. Equivalent circuit and parameter measurements
Week 8 : 15 July - 21 July	Lecture	Topic 5: The Induction Machine 1. Motoring and generating operations 2. Stator current and Power factor 3. Torque-speed characteristics 4. Single-phase induction motors
Week 9 : 22 July - 28 July	Lecture	Topic 6: The Synchronous Machine 1. Working principle 2. Induced voltage and synchronous speed, 3. Generation and motoring operations, 4. Equivalent circuit and parameters, 5. Phasor diagrams of various operation and their applications
Week 10 : 29 July - 4 August	Lecture	Topic 6: The Synchronous Machine 1. The physical meaning of the load angle, 2. Power and torque calculations, 3. Salient pole type SM.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Session Day Time Location

Lectures Mondays 16:00 - 18:00 Webster Theatre A

& Workshops Wednesdays 11:00 - 13:00 Webster Theatre A

Fridays 14:00 - 16:00 Webster Theatre A

Labs Mondays 10:00 - 12:00 EET, Lab 115

Mondays 12:00 - 14:00 EET, Lab 115

Mondays 14:00 - 16:00 EET, Lab 115

Tuesdays 10:00 - 12:00 EET, Lab 115

Tuesdays 12:00 - 14:00 EET, Lab 115

Tuesdays 14:00 - 16:00 EET, Lab 115

Tuesdays 16:00 - 18:00 EET, Lab 115

Wednesdays 14:00 - 16:00 EET, Lab 115
Wednesdays 16:00 - 18:00 EET, Lab 115
Thursdays 10:00 - 12:00 EET, Lab 115
Thursdays 12:00 - 14:00 EET, Lab 115
Thursdays 14:00 - 16:00 EET, Lab 115
Thursdays 16:00 - 18:00 EET, Lab 115
Fridays 10:00 - 12:00 EET, Lab 115
Fridays 12:00 - 14:00 EET, Lab 115

Course Resources

Prescribed Resources

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Moodle

As a part of the teaching component, Moodle will also be used. Lab assessment marks will also be available via Moodle https://moodle.telt.unsw.edu.au/login/index.php. As the course progresses, students' marks from assessments such as labs and the quizzes are available for personal viewing on this website.

Textbooks

Relevant Textbooks

1. Electrical Machinery Fundamentals (prescribed) Author: Stephen J. Chapman (fifth 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

Recommended Resources

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For 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

Course Evaluation and Development

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Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Georgios Konstantinou		Room 325, TETB		Wednesday 10.30 - 11, Webster A & Fridays 12:30 - 13:30 Room 325	No	Yes

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams

- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash

requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

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.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx in the subject line; otherwise they will 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.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage