ENEL 2EE: Electrical and Electronic Engineering

Course Coordinators:

Electronic section

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Course Background and Purpose

This 16-credit course aims to introduce various aspects of electrical and electronic engineering to students who may not necessarily pursue further courses in this discipline at 2nd, 3rd or final year level. The course consolidates and extends existing knowledge of electricity, magnetism and electrostatics from 1st year physics courses, and draws on skills in linear algebra from 1st and 2nd year mathematics courses to solve problems using the principles of circuit theory. Theory is applied to model and analyse simple circuits (which form the basic building blocks of more complex electrical and electronics systems) under various steady state and transient operating conditions. The course also imparts an understanding of the basic operation, equivalent circuit models and analysis of transformers, and alternating current induction motors and provides an introduction to electronic systems, analogue and digital circuitry and instrumentation.

Course Outcomes

On successful completion of the course, the student will be able to:

- Apply circuit theorems and analysis techniques to simplify and solve circuits under steady direct current conditions
- Analyse and predict first order transient behaviour in circuits containing inductors and capacitors
- Use complex variables and phasors to solve circuits under steady alternating current conditions
- Demonstrate a fundamental understanding of the concepts of frequency response and active and reactive power in single and three phase alternating current circuits
- Analyse and predict the performance of single phase transformers and induction motors
- Understand diode and transistor (BJT) characteristics and circuit applications
- Analyse analogue electronic circuits containing diodes and transistors
- Analyse digital electronic circuits containing gates, latches, flip flops, registers, shift registers, counters, etc.
- Interpret the frequency spectra of some elementary periodic and non-periodic signals
- Predict the frequency response (Bode plot) of some simple RC networks
- Understand, analyse and design feedback amplifiers using operational amplifiers
- Use an oscilloscope and multimeter to measure electrical parameters

Engineering Council of South Africa (ECSA) Outcome Contribution

The course contributes at level 2 toward the following ECSA exit level outcomes.

- Application of scientific and engineering knowledge

  Learning outcome: Demonstrate competence to apply knowledge of mathematics, basic science and engineering sciences from first principles to solve engineering problems

- Investigations, experiments and data analysis

  Learning outcome: Demonstrate competence to design and conduct investigations and experiments.

Course Content

Ideal linear circuit elements: voltage and current sources, resistance, capacitance, inductance, current and voltage sign conventions, mesh and nodal analysis of resistive networks, network theorems, transient response of simple circuits, average and rms values of waveforms, sinusoidal steady state and frequency response, phasors and phasor diagrams. Phasor methods in mesh and nodal analysis, j-notation, the concepts of impedance and admittance, active and reactive power, ac circuit theorems, introduction to single phase and three phase power circuits. Magnetic circuit principles. Elementary principles and characteristics of ac transformers. Principles and characteristics of rotating electrical machines. Operation and application of induction machines.

Semiconductor devices: Ideal diode, rectifiers and power supplies. The pn-junction diode. Bipolar junction transistor (BJT), characteristics, switching circuits and small-signal amplifiers.

Digital Electronics: Digital information, gates, combinational systems, sequential systems consisting of latches, flip flops, registers, shift registers and counters and some simple applications.

Analogue electronics: Frequency spectra of some common periodic and non-periodic signals, elementary RC filters, Bode diagrams, operational amplifiers and their use as amplifiers and comparators.

Instrumentation systems: Use of an oscilloscope and multimeter. Measurement techniques.

Laboratory Practical Content

Practical EL2EE2 DC Circuit Theorems: Predict the dc voltages and currents in a circuit using Kirchhoff's voltage and current laws and the Thevénin equivalent circuit and compare with the measured experimental values.

Practical EL2EE9 Electrical Machines: Measure the characteristics of a motor.

Practical EL2EE3 Measurements and Instrumentation: Predict the performance of some elementary circuits and compare this performance with the measured experimental values to understand the operation of a dc power supply, an oscilloscope, a multimeter, a constant voltage source and a constant current source.

Practical EL2EE5 Operational Amplifiers: Predict the performance of some elementary amplifiers and compare with the measured experimental values.

Prerequisites

50 % in PHYS152 or PHYS 162, MATH 132, MATH 141.

ASSESSMENT

Assessment Criteria

The questions in the tests and final exam are designed to assess the student's familiarity with the theoretical aspects of the course and their ability to solve problems on the course material. During the laboratory sessions, students will also be assessed on their ability to conduct relevant experiments and to interpret the results.

Components of Assessment

Students will write four tests (two in the Electrical section and two in the Electronic section), perform four 3-hour laboratory practicals and write a 3-hour examination. The final mark will be made up as follows:

Tests	18% +	Laboratory practicals	12% =	Course Mark 30%
				Final exam 70%
				TOTAL 100%

Due Performance Requirement

For a student to be granted a DP all practicals must be performed satisfactorily. Practical and test marks will be published via the Student Management System (SMS) to the Student Central portal. DP refusals will be implemented on the last day of lectures.

Structure of the Examination

One three-hour closed-book examination.
Electrical section: 50 points. Answer one compulsory question (25 marks), and one out of two additional questions (25 points).
Electronic section: 50 points. Answer one compulsory question (25 marks), and one out of two additional questions (25 points).

Calculators in Examination

Any calculator may be used. Programmable calculators must be cleared prior to the start of any test or exam.

Course Plan

Teaching and Learning Approach

The course material is covered during lecture periods. The lectures are supplemented, where necessary, by free-form explanations and worked examples. Student questions and interaction are encouraged at appropriate intervals. Tutorial problems are provided to assist the students with preparation for the tests and exam, and a selection of these problems are solved for the class during subsequent tutorial periods. Tutorials are not taken in for marking and the onus is on students to attempt the tutorial problems in advance of the tutorial periods in order to be able to assess their own preparedness and to seek assistance if necessary. Students are encouraged to form small tutorial groups which should work together to solve common problems encountered.

This course comprises 52 formal lectures and 13 formal tutorial periods. Informal group tutorial periods may be arranged on request via the elected class representatives.

Tests

Tests will be written under examination conditions in the tutorial period. Students who miss a test must submit written documentation to the respective lecturer to support absence. Lecturers may offer a make-up test to such students on an individual basis in the office.
Lecture/Tutorial Arrangements
lectures/week Electrical section + 2 lectures/week Electronic section.
MONDAYS Periods 2 & 3 in lecture room G01 will cover the Electrical section. WEDNESDAYS and FRIDAYS Period 3 in room G01 will cover the Electronic section.

Office Hour
Course lecturers will each reserve a 45-minute timeslot, at a time in the week agreed to in class, so that students may raise questions individually or in small groups in the office.

Laboratory Practical Arrangements

Students are required to select the days on which they wish to do their practicals. Details will be posted to the course website shortly. Practicals start in the third week of lectures. Students may select their own practical partners to form groups of two for all practicals except ELE2EE9 (which is three) or will be allocated to a group on the afternoon of the practical by the laboratory demonstrators. Note that students may be in different groups for different practicals. The Second Year Laboratory is in the Electrical Engineering South Building, on the second floor, Room 2-07S. Laboratories start promptly at 14:00 and experimental work must be completed by 16:30. The laboratory closes at 17:30.
Remember that attendance and satisfactory performance in all practicals is a DP requirement for the course. Each student will be awarded a mark on completion of the practical based on several factors. Firstly, an assessment of the student's preparedness to undertake the practical, based on the written pre-practical report. Secondly, the student's conduct during the practical, the results obtained and the interpretation of these results.
Repeat students will be required to carry out all practicals to enhance their theoretical understanding of the course work.
Please ensure you are properly attired for labs as per the safety rules, no open footwear, no overly loose clothing, etc.

Information to support the course

Prescribed Text
A R Hambley, Electrical Engineering: Principles and Applications, 5th International Ed, ISBN-13: 978-0-13-215516-8, Pearson Prentice Hall.

Course Website
The website is located at the general address http://learning.ukzn.ac.za Notices, class notes, tutorials, practical and other information will be posted to relevant sections of the website.