ELECTRICAL SCIENCE I - 2024/5

Module code: EEE1034

Module Overview

To understand the physics and engineering that underpins the operation of semiconductor devices and to use this to understand the operation of simple bipolar devices and MOS transistors. In addition to understand the effects electric and magnetic fields and their interaction with matter within the discipline of electronic engineering.

Module provider

Computer Science and Electronic Eng

Module Leader

SHKUNOV Maxim (CS & EE)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 4

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 88

Lecture Hours: 11

Tutorial Hours: 11

Guided Learning: 10

Captured Content: 30

Module Availability

Semester 2

Prerequisites / Co-requisites

None

Module content

Part A - Electronic Materials

Structure of the atom (nucleus, electrons, shells). Ionic bonding (electrostatics). Covalent bonding, Metallic bonding (free electrons). Band structure of insulators, metals and semiconductors. The meaning of the Fermi level.

Intrinsic (Si, Ge) and extrinsic (donor/acceptor, n-type, p-type) semiconductors, carrier concentration. Density of states. Basic band structure description of direct/indirect semiconductors (absorption, emission, phonons). Mobility and conductivity.

Two terminal devices: p-n junctions and diodes (structure and principles of basic operation, Zener, LED, photodiode). Current transport mechanisms.

Three terminal devices: basic physical principles of MOSFET and BJT Transistors, their structures, and electrical characteristics.

Part B - Fields and Charges

Electrostatics: Electric charge, static electricity, fields (conception of scalar vs basic vector) and field lines. Field strength and potential, potential gradients in uniform fields. Capacitance (fields, forces, energy) and dielectrics. Coulomb’s law (test charges, force vs strength vs potential, electrical work). Gauss Law. Applications of electrostatics.

Magnetostatics: Permanent magnets (fields, attraction/repulsion etc) and dc currents (wires, solenoids etc). Magnetic field strength (solenoids, wires, right hand rule, perpendicular components, vector multiplications etc). Bio-Savart Law, Ampere's Law. The ampere (definition using two parallel wires). Coil meters and dc motors. Charged particles in magnetic fields. Hall effect. Applications of magnetic field phenomena. Introduction to electromagnetic induction.

Assessment pattern

Assessment type	Unit of assessment	Weighting
Coursework	TUTORIAL PEER ASSESSMENT SCHEME	10
Examination	2 HOUR CLOSED-BOOK WRITTEN EXAMINATION	90

Alternative Assessment

A student required to resit the TPAS unit of assessment is required to re-submit written answers to all TPAS questions relevant to the module. This re-submission is assessed by the TPAS Coordinator on a pass-fail basis only.

Assessment Strategy

The assessment strategy for this module is designed to provide students with the opportunity to demonstrate the following.

· A breadth of understanding of the underlying science that underpins the operation of 2 and 3 terminal electronic devices. An understanding of processes involved and how they combine in the manufacture of modern integrated circuits. An understanding of the interaction of electric and magnetic fields with matter.

Thus, the summative assessment for this module consists of the following.

· TPAS questions – throughout semester

· Written examination

Formative assessment and feedback

For the module, students will receive formative assessment/feedback in the following ways.

· During lectures, by question and answer session

· During tutorial problem classes

· Through the TPAS system

· By means of unassessed tutorial problem sheets (with answers/model solutions)

Module aims

- Introduce the fundamentals of electric and magnetic fields, conductors, dielectrics and semiconducting materials and their electronic properties.
- Show how the above can be used to explain the behaviour of electronic and photonic devices
- Enable students from different educational backgrounds to reach a common level of knowledge and understanding.
- The module also aims to provide opportunities for students to learn about the Surrey Pillars listed below.

Learning outcomes

		Attributes Developed	
Ref			
001	Discuss bonding between elements and give some of the properties of insulators, metals and semiconductors	KC	C1
002	Describe the main electronic properties of semiconductors and the factors that control electrical conductivity and how they can be utilised in electronic devices.	KC	C1

Ref		Attributes Developed	
003	Discuss the operation of simple devices: diode; bipolar transistor; MOS transistor	KC	C1
004	Demonstrate the application of electrostatic models to describe fields, forces, potential and electrical energy	KC	C2
005	Demonstrate the application of magnetostatic models to charged particles currents and magnetic force.	KC	C2
006	Discuss the origin of electromagnetic induction	KC	C2

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to achieve the following aims.

The learning and teaching strategy is designed to allow the students to gain an understanding of the subject area. At the end of sections the students complete short assessments through the TPAS system and through class tests. This enables the lecturers to assess areas where there are problems. Assessments via TPAS involve peer review marking with scripts returned with explanations so that the students are aware of areas where they are encountering problems and how to solve them. Examination assessment is by multiple choice questions and also longer questions. The teaching uses video clips / multimedia files so the students can see some of the background to the areas they are studying and the processes in industry and so gain an understanding of the bigger picture in which electrical devices operate.

Learning and teaching methods include the following.

- Lectures
- Class discussion and problems
- Revision sessions
- TPAS system of problem classes and peer review marking

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: EEE1034

Other information

The module provides an introduction to semiconductors that are at the basis of every electronic device, thus they underpin all sustainable, renewable technologies. Electrical phenomena underpin the operation of electronic devices and machines that do not use energy derived from fossil fuels. The presence of electronic devices in most objects in everyday life and the freedom of connectivity and information access will give the appreciation of our world being interconnected at various levels, especially via the internet. Students' knowledge and experience is a global value, and they will be able to see the development of technologies from the view of global intelligence.

This module provides ample opportunities for students to engage both in person and via digital content technologies with recorded and captured material, multimedia and web-based information, overall enhancing their digital capabilities for information access and corresponding analysis. This module also helps to realise that the material students study is not "written in stone", but science and technology always develop and evolve and there might not be "the only correct answer". Expected ideal results might not always be realised, however finding alternative solutions and overcoming challenges is the key attitude to solving current and future engineering challenges, thus helping students to develop their resourcefulness and resilience. Such creative attitude toward solving technical problems will also aid students' employability.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Astronautics and Space Engineering BEng (Hons)	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Astronautics and Space Engineering MEng	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Computer and Internet Engineering BEng (Hons)	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Computer and Internet Engineering MEng	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Electrical and Electronic Engineering BEng (Hons)	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Electrical and Electronic Engineering MEng	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Electronic Engineering BEng (Hons)	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Electronic Engineering MEng	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Electronic Engineering with Computer Systems BEng (Hons)	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Electronic Engineering with Computer Systems MEng	2	Compulsory	A weighted aggregate mark of 40% is required to pass the module

Please note that the information detailed within this record is accurate at the time of publishing and may be subject to change. This record contains information for the most up to date version of the programme / module for the 2024/5 academic year.