Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

UNDERGRADUATE STUDENT HANDBOOK

YEAR M (FHEQ LEVEL 7)

SEMICONDUCTOR TECHNOLOGY AND APPLICATIONS

DEGREE PROGRAMMES

SUBJECT SPECIFIC
PART TWO OF TWO
MODULE AND COURSE STRUCTURE
2022-23

DISCLAIMER

The Faculty of Science and Engineering has made all reasonable efforts to ensure that the information contained within this publication is accurate and up-to-date when published but can accept no responsibility for any errors or omissions.

The Faculty of Science and Engineering reserves the right to revise, alter or discontinue degree programmes or modules and to amend regulations and procedures at any time, but every effort will be made to notify interested parties.

It should be noted that not every module listed in this handbook may be available every year, and changes may be made to the details of the modules. You are advised to contact the Faculty of Science and Engineering directly if you require further information.

The 22-23 academic year begins on 26 September 2022

Full term dates can be found here

DATES OF 22-23 TERMS
26 September 2022 – 16 December 2022
9 January 2023 – 31 March 2023
24 April 2023 – 09 June 2023

SEMESTER 1
26 September 2022 – 27 January 2023
SEMESTER 2
30 January 2023 – 09 June 2023
SUMMER
12 June 2023 – 22 September 2023

IMPORTANT

Swansea University and the Faculty of Science of Engineering takes any form of **academic misconduct** very seriously. In order to maintain academic integrity and ensure that the quality of an Award from Swansea University is not diminished, it is important to ensure that all students are judged on their ability. No student should have an unfair advantage over another as a result of academic misconduct - whether this is in the form of **Plagiarism**, **Collusion** or **Commissioning**.

It is important that you are aware of the **guidelines** governing Academic Misconduct within the University/Faculty of Science and Engineering and the possible implications. The Faculty of Science and Engineering will not take intent into consideration and in relation to an allegation of academic misconduct - there can be no defence that the offence was committed unintentionally or accidentally.

Please ensure that you read the University webpages covering the topic – procedural guidance here and further information here. You should also read the Faculty Part One handbook fully, in particular the pages that concern Academic Misconduct/Academic Integrity. You should also refer to the Faculty of Science and Engineering proof-reading policy and this can be found on the Community HUB on Canvas, under Course Documents.

Welcome to the Faculty of Science and Engineering!

Whether you are a new or a returning student, we could not be happier to be on this journey with you.

This has been a challenging period for everyone. The COVID-19 pandemic has prompted a huge change in society as well as how we deliver our programmes at Swansea University and the way in which you study, research, learn and collaborate. We have been working hard to make sure you will have or continue to having an excellent experience with us.

We have further developed some exciting new approaches that I know you will enjoy, both on campus and online, and we cannot wait to share these with you.

At Swansea University and in the Faculty of Science & Engineering, we believe in working in partnership with students. We work hard to break down barriers and value the contribution of everyone. Our goal is an inclusive community where everyone is respected, and everyone’s contributions are valued. Always feel free to talk to academic staff, administrators, and your fellow students - I’m sure you will find many friendly helping hands ready to assist you.

We all know this period of change will continue and we will need to adapt and innovate to continue to be supportive and successful. At Swansea we are committed to making sure our students are fully involved in and informed about our response to challenges.

In the meantime, learn, create, collaborate, and most of all – enjoy yourself!

Professor Johann (Hans) Sienz
Interim Pro-Vice Chancellor/Interim Executive Dean
Faculty of Science and Engineering

Faculty of Science and Engineering	
Interim Pro-Vice Chancellor/Interim Executive Dean	Professor Johann Sienz
Head of Operations	Mrs Ruth Bunting
Associate Dean – Student Learning and Experience (SLE)	Professor Paul Holland
School of Engineering and Applied Sciences **Head of School: Professor Serena Margadonna**	
School Education Lead	Professor Simon Bott
Head of Chemistry	Professor Owen Guy
Chemistry Programme Director	Dr Joel Loveridge
Course Coordinator for MSc Semiconductors	Professor Owen Guy

STUDENT SUPPORT

The Faculty of Science and Engineering has two **Reception** areas - Engineering Central (Bay Campus) and Wallace 223c (Singleton Park Campus).

Standard Reception opening hours are Monday-Friday 9am-5pm.

The **Student Support Team** provides dedicated and professional support to all studentsin the Faculty of Science and Engineering. Should you require assistance, have any questions, be unsure what to do or are experiencing difficulties with your studies or in your personal life, our team can offer direct help and advice, plus signpost you to further sources of support within the University. There are lots of ways to get information and contact the team:

Email: studentsupport-scienceengineering@swansea.ac.uk (Monday–Friday, 9am–5pm)

Call: +44 (0) 1792 295514 and 01792 6062522 (Monday-Friday, 10am–12pm, 2–4pm).

Zoom: By appointment. Students can email, and if appropriate we will share a link to our Zoom calendar for students to select a date/time to meet.

The current student **webpages** also contain useful information and links to otherresources:

https://myuni.swansea.ac.uk/fse/coe-student-info/

READING LISTS

Reading lists for each module are available on the course Canvas page and are also accessible via http://ifindreading.swan.ac.uk/. We've removed reading lists from the 22-23 handbooks to ensure that you have access to the most up-to-date versions. Access to print material in the library may be limited due to CV-19; your reading lists will link to on-line material whenever possible. We do not expect you to purchase textbooks, unless it is a specified key text for the course.

THE DIFFERENCE BETWEEN COMPULSORY AND CORE MODULES

Compulsory modules must be **pursued** by a student.

Core modules must not only be **pursued**, but also **passed** before a student can proceed to the next level of study or qualify for an award. Failures in core modules must be redeemed.

Further information can be found under "Modular Terminology" on the following link - https://myuni.swansea.ac.uk/academic-life/academic-regulations/taught-guidance/essential-info-taught-students/your-programme-explained/

MSc (FHEQ Level 7) 2022/23
Semiconductor Technology and Applications
MSc Semiconductor Technology and Applications

Coordinator: Prof OJ Guy

Semester 1 Modules	Semester 2 Modules
EGLM00 Power Semiconductor Devices 10 Credits Prof MR Jennings	EGLM01 Wide band-gap Semiconductors 10 Credits Dr TGG Maffeis/Prof OJ Guy
EGLM02 Advanced Power Electronics and Drives 10 Credits Dr Z Zhou	EGNM09 Micro and Nano Electro-Mechanical Systems 10 Credits Prof L Li
EGNM01 Probing at the Nanoscale 10 Credits Dr TGG Maffeis/Prof KS Teng/Dr CJ Wright	SC-M02 Next Generation Semiconductor Applications 10 Credits Prof OJ Guy/Prof A Armin/Dr MJ Roach
SC-M01 Semiconductor Processing 20 Credits Prof OJ Guy	SC-M03 Processable Electronics 10 Credits Dr JW Ryan/Prof MJ Carnie/Dr E Evans/Prof OJ Guy
SC-M06 Literature Skills and Review 10 Credits Prof OJ Guy	SC-M04 Semiconductor Device Physics 10 Credits Prof A Armin
	SC-M05 Research and Industry Skills and Professional Development 10 Credits Prof OJ Guy/Prof MR Jennings
Dissertation	
SC-D01 MSc Dissertation - Semiconductors 60 Credits Prof OJ Guy	
Total 180 Credits	

EGLM00 Power Semiconductor Devices

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof MR Jennings

Format: Formal contact hours: 20 hours
Directed private study: 80 hours

Delivery Method: Module exam 100%

Module Aims: Power semiconductor technology is a key enabling technology leading to more efficient power conversion. Historically, the development of electronic power devices can be traced to the early 1950s when thyristors capable of operating at high current and voltages were introduced. In the years to come, the most important development has been the introduction of power devices with high-input-impedance gate such as VDMOSFETs and IGBTs. This allowed a large reduction in system size and cost, leading to many new application for power electronics in domestic appliances and automotive and aviation electronics, for example.

Module Content:

• Power electronics and energy management in the New Millennium.
• Semiconductor fundamentals.
• Power diodes
- Bipolar devices.
• Power MOSFET.
- Insulated Gate Bipolar Transistors (IGBT).
- Device switching.
- Device losses.
- Device fabrication of practical devices.
• RESURF and super-junction devices.
• Power electronics applications.
- Advanced concepts, lifetime control, junction termination, high voltage (smart) power ICs.
- Wide bandgap semiconductors and devices. An insight into silicon carbide and gallium nitride, its advantages and potential (high voltage, high frequency and high temperature devices) and its problems (cost, immaturity, processing issues).
- Packaging and reliability of power semiconductor devices.

Intended Learning Outcomes: By the end of the module the student should be able to...
• Apply advanced concepts through the use of device physics in the context of device design (forward, reverse characteristics and switching) for use within a power converter.
• Design a power semiconductor device for a specific application.
• Conduct complex packaging and reliability analysis of power semiconductor devices.
• Analyse systematically new materials for power semiconductor devices; silicon carbide and gallium nitride.

Accreditation Outcomes (AHEP)
MEng
- Awareness of developing technologies related to own specialisation (SM4m)
- A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations (SM5m)
- Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques (EA2m)
- Ability to apply quantitative and computational methods, using alternative approaches and understanding their limitations, in order to solve engineering problems and to implement appropriate action (EA3m)
- Demonstrate wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D7m)
- Demonstrate the ability to generate an innovative design for products, systems, components or processes to fulfil new needs (D8m)
- Understanding of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate (ET4m)
- A thorough understanding of current practice and its limitations, and some appreciation of likely new developments (EP9ml)

MSc
- A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation (SM2fl)
- Understanding of concepts relevant to the discipline, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in Engineering projects (SM3fl)
- Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations (EA1fl)
- Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D2fl)
- Ability to generate an innovative design for products, systems, components or processes to fulfil new needs (D3fl)
- Awareness that engineering activities should promote sustainable development and ability to apply quantitative techniques where appropriate (ET4fl)
- A thorough understanding of current practice and its limitations, and some appreciation of likely new developments (EP2fl)

Assessment: Examination (100%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination - 2 hours

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: An exam feedback form will be produced noting common errors and good practice. This will be uploaded to the College of Engineering Community page.

Failure Redemption: Resit examination in August worth 100%.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

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EGLM01 Wide band-gap Semiconductors

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr TGG Maffeis, Prof OJ Guy

Format: 23 h lecture/on demand
2 h pc lab
55 hours private study
20 hours assessment preparation

Delivery Method: Lecture either online or face to face, and PC lab based module.
Assessment: 80% final exam, 20% continual assessment (2x10%).

Module Aims: State-of-the-art wide band gap semiconductor materials and technology will be considered with emphasis on diamond, silicon carbide, gallium nitride and metal oxides. The course will cover everything from materials growth through device processing technology, to devices and applications. Current commercial devices and anticipated devices will be highlighted and discussed. The semiconductor physics needed for devices simulation and an introduction to device simulation will be covered. Metal oxide wide band gap semiconductors and their applications in renewable energy generation will be discussed.

Module Content:

- Introduction to wide band-gap materials: structure and material properties of diamond, silicon carbide & gallium nitride.
- Materials Growth.
- Electronic properties and applications.
- Basic requirements of power devices.
- Types of wide bandgap devices.
- Diodes: Schottky diodes & PiN diodes.
- Field Effect Transistors (FETs): MOSFETs, MESFETs.
- Device processing technology: Material analysis, Contact formation, Implantation, Dielectrics, Etching.
- Semiconductor physics background.
- Device testing & characterisation; State of the art device technology.
- Electronic materials for renewable energy generation.
- Solar power and photo-voltaics.

Intended Learning Outcomes: Technical outcomes:
• A detailed knowledge and comprehensive understanding of wide band gap materials including the techniques for the design, fabrication and characterisation of devices
• A comprehensive understanding of the semiconductor physics governing device behaviour
• A critical awareness of the pros and cons of novel wide band gap materials.
• An ability to identify the key differences between simulation and experiment
• How to design and fabricate devices.

Accreditation outcomes (AHEP):

MEng
- A comprehensive knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies (SM1m)
- Awareness of developing technologies related to own specialisation (SM4m)
- Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes (EA1m)
- Communicate their work to technical and non-technical audiences (D6m)
- Demonstrate wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D7m)
- Knowledge of characteristics of particular equipment, processes, or products, with extensive knowledge and understanding of a wide range of engineering materials and components (EP2m)
- Understanding of the use of technical literature and other information sources (EP4m)
- A thorough understanding of current practice and its limitations, and some appreciation of likely new developments (EP9m)

MSc
• A comprehensive understanding of the relevant scientific principles of the specialisation (SM1fl)
• A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation (SM2fl)
• Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations (EA1fl)
• Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D2fl)
• Advanced level knowledge and understanding of a wide range of engineering materials and components (EP1fl)
• A thorough understanding of current practice and its limitations, and some appreciation of likely new developments. (EP2fl)
• The ability to apply engineering techniques, taking into account of a range of industrial and commercial constraints (EP3fl)
• Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader (EP4fl)

Assessment:	Examination 1 (80%)
	Coursework 1 (10%)
	Oral Presentation (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Assessments: Exam (80%), exercise sheet (10%) and oral presentation (10%) Course work components: Coursework 1: (Prof. Guy) Problem sheet (exam type questions): Assessment in April - worth 10%. This is an individual piece of coursework. Groupwork Coursework: (Prof. Guy) Oral presentations - PowerPoint presentations given by small groups on course. related topics: Assessment in April - worth 10%. This is an individual piece of coursework. This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.
Moderation approach to main assessment: Universal second marking as check or audit
Assessment Feedback: - Written feedback on formal exam. - Oral feedback on CA.
Failure Redemption: If rules allow - standard University provisions with marks capped. Any re-examination of this module will be by written examination only (100%).
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. • There is a zero tolerance towards late submission of coursework. • Advanced semiconductor materials like diamond, silicon carbide and gallium nitrate are necessary to increase energy efficiency of electronic devices to reduce carbon emissions. These new materials are expected to replace silicon in aerospace, energy and automotive (hybrid electric vehicles) sectors in the near future. • This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

EGLM02 Advanced Power Electronics and Drives

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr Z Zhou

Format: On demand online teaching: 16 hours
On demand example and coursework support 6 hours
Directed private study: 78 hours
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

This module is delivered by a combination of on-line teaching and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

Assessment: open-book examination (80%) and continuous assessment (20%)

The examination is worth 80% of the module. Answer 4 questions. Each question answered will be worth 25%. The examination topics will be those presented directly in the lectures.

The continuous assessment is worth 20% of the module. This is based on an assignment related to the simulation and analysis of power electronics converter circuits.

Module Aims: This module introduces advanced circuit topologies of power electronics systems for high power applications; the power quality issues will also be addressed by covering passive and active power filters, front end active circuit topologies and harmonic standards. An introduction to modern variable speed AC and DC drives for industrial applications will also be introduced.

Module Content:

- Power converter circuit topologies for renewable energy systems.
- Multi pulse rectifiers.
- Multilevel converters for high power applications.
- Power quality issues at the Point of Common Coupling (PCC).
- Harmonics analysis of converters
- An introduction to grid interface of power electronics converters as well as AC and DC drives

Intended Learning Outcomes:
After completing the module you should be able to:

Design:
• Power electronics circuit topologies for medium power applications including renewable energy systems and electrical AC/DC drives.
• Multi-pulse rectifiers and multi-Level inverters for high power applications as well as design grid interface of power electronics converters.

Analyse:
• Power electronics circuit topologies for medium to high power applications including renewable energy systems and AC/DC drives.
• Harmonic content of systems and compliance to international standards.

Accreditation Outcomes (AHEP)
Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations (EA1fl)
Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies (D1fl)
Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D2fl)
Advanced level knowledge and understanding of a wide range of engineering materials and components (EP1fl)
Awareness of relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues (ET5p)

Assessment:	Examination (80%)
	Assignment 1 (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Due to COVID-19, an alternative assessment has been put in place:

examination (80%) and continuous assessment (20%)

The take-home examination is worth 80% of the module, answer 4 questions. Each question answered will be worth 25%. The examination topics will be those presented directly in the lectures.

The continuous assessment is worth 20% of the module. This is based on an assignment related to the simulation and analysis of power electronics circuits.

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the examination, the students will receive an examination feedback summary sheet giving details of the common mistakes that were identified from the assessed exam scripts. It also lists the maximum, minimum and means marks for each question and the number of students attempting it. Feedback specific to each question is additionally provided to aid the students.

For the continuous assessment, the students will receive feedback giving details of the common mistakes that were identified from the submitted coursework. Individually students can make an appointment with the lecturer to receive individual feedback on the assignment if this is required.

Failure Redemption: If rules allow - standard University provisions with marks capped. Any re-examination of this module will be by written examination only (100%).

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

AVAILABLE TO visiting and exchange students

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

EGNM01 Probing at the Nanoscale

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr TGG Maffeis, Prof KS Teng, Dr CJ Wright

Format: Lectures: 17 hours
Revision classes: 3 hours
Laboratory: 3 hours
Directed private study: 24 hours
Personal revision: 50 hours
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Content delivered by lecture, with supervised lab sessions using scanning probe microscopes requiring a formal laboratory report. Additional data analysis exercises.

Module Aims: This module provides an introduction to the analysis techniques used in nanotechnology, and general surface science, including scanning probe microscopy, electron and diffraction techniques.

Module Content: A general introduction to nanotechnology including the principles of operation and useful applications of a variety of scanning probe microscopy (SPM) techniques, including atomic force microscopy (AFM), scanning tunnelling microscopy (STM), scanning near field optical microscopy (SNOM) and Kelvin probe force microscopy (KPFM). Consideration is given to their appropriate use, data analysis and benefits over conventional microscopy. In addition, novel SPM techniques are explored. Traditional surface science techniques such as x-ray photoelectron spectroscopy (XPS), auger electron spectroscopy (AES) and secondary ion mass spectroscopy (SIMS) are also covered within this module.

Intended Learning Outcomes: Technical Outcomes:
After completing this module you should be able to:
• Understand the demands and requirements of measuring, characterising and manipulating materials and devices at the nanoscale
• Explain a variety of different analysis tools used at this length scale, including scanning probes, diffraction and electron microscopy techniques.
• Apply the scientific principles behind nanoscale analysis to explain the different analysis techniques used
• To bring together all the above to design an experiment based on the required measurement, cost, accuracy level, device limitations and other requirements, across a range of materials and devices spanning semiconductors, metals, oxides and biological materials.
• To analyse data, extract physical quantities and assess a material or device with potentially incomplete data sets, and to use the literature to supplement missing knowledge.
• To operate and use scanning probe microscopes and be exposed to a wider range of analysis tools within the department, to collect, analyse and interpret data and to undertake a risk assessment exercise prior to using the laboratories
• To critically assess the results in terms of information resources and communicate the importance of the data and results and produce a report based on this information.

Accreditation Outcomes:
l Understanding of concepts relevant to the discipline, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in engineering projects. (SM3fl)
Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations. (Ea1fl)
Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques. (EA2m)
Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies. (D1fl)
Advanced level knowledge and understanding of a wide range of engineering materials and components (EP1fl)
Knowledge of characteristics of particular equipment, processes, or products, materials and components; (Ep2M)

Assessment:	Examination 1 (80%) Assignment 1 (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination and Coursework
Written final exam: 80%
Assignment 1: Data Analysis Exercise 20%.

• This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback:
Written final exam: standard university examination feedback forms.
SPM lab report and lab diary: marked assignments returned to students.
STM, STS and AFM data analysis assignments: mark returned to students.

Failure Redemption: If rules allow - standard University provisions with marks capped. Any re-examination of this module will be by written examination only (100%).

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Support material and past exam questions available on Canvas.

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

EGNM09 Micro and Nano Electro-Mechanical Systems

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof L Li

Format: Lectures: 20 hours
Example Classes: 2 hours
Directed Private Study: 78 hours
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Lectures and end of semester examination.

Module Aims: Micro and Nano Electro-Mechanical Systems (MEMS/NEMS) are technology that integrates electrical and mechanical components and they offer many novel and diverse applications ranging from display technologies to sensor systems.

Module Content: Introduction to MEMS and NEMS
Modelling the Dynamics of MEMS/NEMS
MEMS/NEMS Sensors and Actuators
Piezoelectric, electrostatic, and thermoelectric
Fabrication of MEMS/NEMS
Optical and RF MEMS

Intended Learning Outcomes: Technical Outcomes:
After completing this module you should be able to demonstrate:
• Ability to analyse the dynamic motion of micro/nano resonators based on mass-spring-damper model.
• Ability to use mathematical tools (such as Matlab) to simulate key parameters of micro/nanoelectromechanical systems.
• Ability to analyse how the physical and electronic properties change with dimension and how this affects devices, and comprehensive understanding of why the devices are realized in micro/nano scales.
•Ability to model the electronic/physical/mechanical properties of the piezoelectric crystals, electrostatic and thermoelectric devices, and to apply these devices in optical, radio frequency, and power generation systems.
• Ability to conduct multi-physics modelling encompassing disciplines such as electronics, physics, and mechanics.
• Ability to design microfabrication processes for target micro/nanoelectromechanical devices.

Accreditation Outcomes (AHEP)
- A comprehensive understanding of the relevant scientific principles of the specialisation (SM1fl)
- Ability to generate an innovative design for products, systems, components or processes to fulfil new needs (D3fl)
- Ability to use fundamental knowledge to investigate new and emerging technologies (EA2fl)

Assessment: Examination 1 (80%)
Assignment 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: 80% End term Examination
20% Mid term assignment

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: Students receive feedback from formal examination via standard College proforma.

Failure Redemption: If rules allow - standard university provision of Supplementary examination, with marks capped at 40% and by written examination only (100%).

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 40% in the exam component. If you achieve less than 40% in the exam, then the module mark will be just the exam mark.

SC-D01 MSc Dissertation - Semiconductors

Credits: 60 Session: 2022/23 January-September

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof OJ Guy

Format: Typically 1 hour per week i.e 10-15 hrs total contact time. Each student is to be supervised in accordance with the University's Policy on Supervision, with a minimum of three meetings held. A careful record should be kept, agreed between supervisor and student, of all such formal meetings, including dates, action agreed and deadlines set.

Delivery Method: The module is delivered primarily as an individual research project. The student is expected to liaise with the supervisor on a regular basis, with a minimum University requirement of three formal meetings for full-time students. In the case of part-time students it is recommended that a minimum of four meetings are held. Ideally, contact should be more regular, with at least one meeting a week to discuss the development and progress of the project. Depending on the project the student would be expected to carry out this research individually and to complete the necessary risk assessments and training required to work on an industrial site or within laboratory facilities of the University.

Module Aims: The module aims to develop fundamental research skills. It comprises the development of supervised research work leading to a dissertation in the field of Semiconductor Technology and Applications. The specific research topic will be chosen by the student following consultation with academic staff.

Module Content: Study for the dissertation, which may be based on practical (which can be hands-on or based on simulations), industrial, or literature work, or any combination of these, is primarily carried out over a period of about 12 weeks, with the dissertation being submitted at the end of September. Preparatory work on the dissertation may take place during Part One of the programme but students will only be permitted to submit their dissertation following successful completion of Part One.

Students should select the topic and methodology after discussions with the appropriate potential project supervisor(s).

In conducting the research project and dissertation the student will be exposed to all aspects of modern information retrieval processes, the organisation and resourcing of research and the organising and presentation of experimental data. The student must make inferences on conclusions, based on the evidence provided and supported by the research work. Furthermore they must assess the significance of this work in relation to the field and make suggestions about how further work could improve or clarify the research problem. The results of the project will be disseminated in a substantial dissertation demonstrating the student's ability to research a subject in depth.

The student will meet regularly with the supervisor to ensure that the project is well developed and organised. Ideally these meetings will be weekly. Progress will be recorded and reported to the overall coordinator through formal meetings. There will be at least 3 of these for students working on campus and 4 for students working off campus (with their university supervisor).

Intended Learning Outcomes: On completion of this module, students should have the ability to:
- Investigate a research topic in detail;
- Formulate research aims;
- Devise and plan a research strategy to fulfil the aims;
- Carry out research work - undertake a literature search, a laboratory based or computer based investigation or a combination of these;
- Gather, organize and use evidence, data and information from a variety of primary and secondary sources;
- Critically analyse information;
- Make conclusions supported by the work and identify their relevance to the broader research area;
- Resolve or refine a research problem, with reasoned suggestions about how to improve future research efforts in the field;
- Produce a report (dissertation), with the findings presented in a well organised and reasoned manner.

Assessment Description: The research project and dissertation forms Part Two of the Masters degree.

Students should refer to:
https://www.swansea.ac.uk/academic-services/academic-guide/postgraduate-taught-awards-regulations/standard-taught-masters/

In particular, section 14 will provide further Information about dissertation preparation and submission.

The word limit is 20,000. This is for the main text and does not include appendices (if any), essential footnotes, introductory parts and statements or the bibliography and index.

Each student is to submit an electronic copy of their dissertation through the Turnitin link on Canvas. The online system will automatically check the similarity of the report. The dissertation must contain:

• A statement that it is being submitted in partial fulfilment of the requirements for the degree;
• A summary of the dissertation not exceeding 300 words in length;
• A statement, signed by you, showing to what extent the work submitted is the result of your own investigation. Acknowledgement of other sources shall be made by footnotes giving explicit references. A full bibliography should be appended to the work;
• A declaration, signed by you, to certify that the work has not already been accepted in substance for any degree, and is not being concurrently submitted in candidature for any degree; and
• A signed statement regarding availability of the thesis.

The dissertation is marked by the supervisor and another member of staff and sent to an External Examiner for moderation. An Internal Exam Board is then held to confirm the mark. Finally, all marks are ratified at the University Postgraduate Taught Examination Board.

Moderation approach to main assessment: Universal double-blind marking

Assessment Feedback: Informal feedback will be given during regular meetings with supervisors. The supervisor will also provide an assessment of the project drafting skills during the planning of the dissertation. Work will be returned according to specified deadlines and accompanied by constructive comment.

A Feedback session will be given to any student who fails their dissertation and is permitted by the Award Board to resubmit their work.

Failure Redemption: Candidates who fail the dissertation are given an opportunity to resubmit the dissertation within 3 months of the result of the examination if a full-time student or 6 months for part-time students. Such students will be given one formal feedback session, including written feedback on the reasons for failure, immediately following confirmation of the result by the University Postgraduate Taught Examination Board. The opportunity to resubmit will only be offered to students who submit a dissertation and are awarded a fail. Those candidates who do not submit a dissertation will not be offered a resubmission opportunity.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

SC-M01 Semiconductor Processing

Credits: 20 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof OJ Guy

Format: 20 hours seminars/workshops,
20 hours practical,
100 hours independent study,

60 hours preparation for assessment

Delivery Method: Onsite and online seminars, workshops and meetings, practical wafer fab sessions

Module Aims: This module takes us on a journey from sand (silicon dioxide) to silicon and then on to semiconductor devices such as transistors. The process of fabricating semiconductor devices is conducted in cleanroom environments in large Semiconductor Foundries (Wafer Fabs). The course will explore all of the processes required to produce a semiconductor wafer (both silicon and compound semiconductors) and detail the process technologies used to fabricate devices (doping, metalisation, dielectric deposition, photolithography and etching), highlighting the different process requirements for different materials. This module will also cover the fabrication of some specific devices such as diodes, transistors (MOSFETs, MESFETs, JFETs, HEMTs) and photonic devices.

Module Content: • Introduction to semiconductor (basic concepts, doping, carriers, mobility, crystal structures, defects…..)
• Overview of Semiconductor Materials [silicon, Compound Semiconductors (SiC, III-Vs, II-Vis), Diamond, graphene, Organics]
• Wafer production (Silicon, Compound Semiconductor Growth)
• Introduction to devices (diodes, transistors and photonic devices).
• Device Processing:
• Doping
• Photolithography, EUV, EBL, Laser Writing
• Plasma Processing, RF & DC Plasma generation, Plasma etching anisotropic (Bosch Process optimisation), Plasma deposition PVD, CVD, MVD/MVD
• Wet and vapour etching processes, metal, semiconductor and dielectric etching, comparing to dry etch.
• MEMS
• Back end processing, 3D stacked chips, TSVs, Dicing (stealth, saw, disco, plasma). Wire bonding, ball bonding, flip chip,
• Packaging

Intended Learning Outcomes: By the end of this modules, students will be able to

• Explain and critique the fundamental science behind semiconductors

• Describe and compare the different materials that show semiconductor properties

• Describe and distinguish between different types of semi-conductor devices

• Describe and distinguish between different processes for fabricating devices

• Appraise reasons for different processes for different devices

Assessment: Group Work - Practical (20%)
Examination (80%)

Assessment Description: Students will work in group to fabricate devices in a clean room. This will be assessed continually in the clean room and through a short individual report (1500-2000 words).

The end of term exam will be comprehensive over all topics covered.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students will receive feedback on all assessed work through verbal, written and online media. Students will meet with academic mentors twice during the module to assess their progress, identify challenges and to provide feedback. Students will also seek advice and verbal, written or online feedback from mentor and external contributors to the module to assist in the preparation of their assignment.

Failure Redemption: A suitable supplementary attempt will be permitted on relevant assessment in line with University policy.
Additional Notes: Suitable for exchange students with appropriate backgrounds.

SC-M02 Next Generation Semiconductor Applications

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof OJ Guy, Prof A Armin, Dr MJ Roach

Format: 20 hours seminars/workshops,
40 hours independent study,
40 hours preparation for assessment

Delivery Method: Onsite and online seminars, workshops and meetings

Module Aims: We interact with semiconductor devices hundreds of times a day as we connect with the world and with each other. The internet of things (IoT) is connecting more and more devices, creating smart networks for individuals, companies and communities. Semiconductor devices are at the heart of all new technology from smart devices, electric cars and 5G and are vital for the next generation of technologies. This module will discuss the latest device technology and the roadmap to even smaller devices. We will look at applications of these devices in photonics and communications, AI, Energy. The second part of the course will focus on applications of semiconductors and semiconductor technologies for energy generation and storage, transmission and distribution, transport and healthcare.

Module Content: • More than Moore (transistors architecture)
• Beyond 5 nm Transistors
• Quantum technologies (Quantum Devices, Spintronics)
• Photonics
• Waveguides
• 5G, 6G
• AI Information Electronics
• Robotics
• Solar PV
• Energy Storage
• Energy Transmission Distribution
• Transport
• Semiconductors in Health (BioMEMS, Sensors, Imaging, Data)

Intended Learning Outcomes: By the end of this modules, students will be able to

• Discuss and compare device technology and applications

• Compare different devices and examine their different broad applications

• Appraise and critique proposed roadmaps to smaller devices

• Select appropriate devices and properties for specific applications in energy

• Select appropriate devices and properties for specific applications in healthcare

Assessment: Examination (80%)
Assignment 1 (10%)
Assignment 2 (10%)

Assessment Description: Students will write two 500 word papers each covering a specific application of their choice
The end of term exam (2 hours) will be comprehensive over all topics covered.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students will receive feedback on all assessed work through verbal, written and online media. Students will meet with academic mentors twice during the module to assess their progress, identify challenges and to provide feedback. Students will also seek advice and verbal, written or online feedback from mentor and external contributors to the module to assist in the preparation of their assignment.

Failure Redemption: A suitable supplementary attempt will be permitted on relevant assessment in line with University policy.

Additional Notes: Suitable for exchange students with appropriate backgrounds.

SC-M03 Processable Electronics

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr JW Ryan, Prof MJ Carnie, Dr E Evans, Prof OJ Guy

Format: 20 hours seminars/workshops,
40 hours independent study,
40 hours preparation for assessment

Delivery Method: Onsite and online seminars, workshops and meetings

Module Aims: Since the 1970s, plastic electronics has expanded into a multitude of technologies and products incorporating flexible and transparent electronic circuits. Polymers or inks can be used as printable inks onto polymer-based substrates using various printing technologies, spin coating or vacuum deposition. Plastic electronics can use printed inks on plastic substrates, or it can consist of organic conductive polymers. Applications of plastic electronics will be discussed.

Module Content: • Plastic electronics overview
• Printed inks and printing processes
• Substrate selection
• Printed devices
• Organic electronics and conducting polymers
• Molecular Orbitals, Electronic transitions in semiconducting and semi-metal polymers
• Organic electronic devices (OFETs, OTFTs)
• Photo process and light emission
• OLEDs and OPV

Intended Learning Outcomes: By the end of this modules, students will be able to

• Discuss and contrast plastics electronics technologies and applications

• Select and defend the selection of different inks, substrates and printing processes depending on the application

• Discuss and critique the fundamental molecular and nanolevel explanations of different polymer properties

• Critique and support these molecular and nanolevel explanations applied to different applications of the polymers

• Predict and design possible polymers suitable for further applications

Assessment: Examination (80%)
Assignment 1 (10%)
Assignment 2 (10%)

Assessment Description: Students will write two 500 word papers, covering a current application and potential application of these technologies
The end of term exam (2 hours) will be comprehensive over all topics covered.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students will receive feedback on all assessed work through verbal, written and online media. Students will meet with academic mentors twice during the module to assess their progress, identify challenges and to provide feedback. Students will also seek advice and verbal, written or online feedback from mentor and external contributors to the module to assist in the preparation of their assignment.

Failure Redemption: A suitable supplementary attempt will be permitted on relevant assessment in line with University policy.

Additional Notes: Suitable for exchange students with appropriate backgrounds.

SC-M04 Semiconductor Device Physics

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof A Armin

Format: 22 lectures

Delivery Method: Onsite and online seminars, workshops and meetings

Module Aims: This module covers semiconductor device physics with the emphasis on the "next generation" solar cells made of disordered semiconductors.

Module Content: • Brief review on semiconductors - electrons in semiconductors, density of state, holes, thermal equilibrium, doping, quasi Fermi level distributions, work function, photo-generation of electrons and holes.
• Semiconductor devices - transition from vacuum valves to modern electronics, p-n junction, metal-semiconductor contact, Schottky contact, MIS contact, transistors, solar cells, LEDs and lasers, photodetectors.
• Solar cells - electrochemical equilibrium of electrons in a p-n junction, current-voltage characteristics, photo-generation in excitonic and non-excitonic solar cells, organic solar cells, detailed balance theory and thermodynamic limit of photovoltaics.
• Organic solar cells - organic semiconductors, donors and acceptors, device optics, charge transfer states, mechanism of recombination, charge carrier collection, scaling-up.

Intended Learning Outcomes: • Demonstrate an understanding of and appraise the basic principles of semiconductor devices physics
• Solve problems of theoretical and practical significance
• Differentiate between the underlying nanolevel explanations of semiconductor materials
• Compare the nature and the properties of different semiconductor devices
• Relate the nanoscale and macroscale properties of general solar cells to organic solar cells

Assessment: Examination (50%)
Presentation (25%)
Assignment 1 (25%)

Assessment Description: A 2 hour comprehensive exam
A group presentation lasting 5-7 minutes per person discussing background, theory and applications of one type of semiconductor device
A take-home problem sheet covering the entire semester content

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students will receive feedback on all assessed work through verbal, written and online media. Students will meet with academic mentors twice during the module to assess their progress, identify challenges and to provide feedback. Students will also seek advice and verbal, written or online feedback from mentor and external contributors to the module to assist in the preparation of their assignment.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

This module covers the same material as PH-300 but with higher order learning objectives and assessments

SC-M05 Research and Industry Skills and Professional Development

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof OJ Guy, Prof MR Jennings

Format: 30 hours seminars/workshops,
30 hours independent study,
40 hours preparation for assessment

Delivery Method: Onsite and online seminars, workshops and meetings

Module Aims: This module is designed to provide an overview of multiple skills that will be needed by the professional in the semiconductor (and other) industries.

Module Content: • Structure of organisations and projects
• Communication skills
• Presentation skills
• Leadership and teamwork
• Planning for success
• Change management
• Schedule and resource management
• Procurement
• Project risk management and issue management
• Project quality management
• Intellectual Property

Intended Learning Outcomes: By the end of this modules, students will be able to

• define a project clearly and optimise the balanced between quality, budget and time.

• plan and produce Gantt charts for project planning and time management

• demonstrate an understanding of skills required for team working, delegation and leadership

• demonstrate an understanding of the legalities and other issues associated with intellectual property

• create a comprehensive project plan containing the project aims, expected timelines, estimated costs and key risks to success

Assessment: Group Work - Project (50%)
Assignment 1 (25%)
Assignment 2 (25%)

Assessment Description: Students will work in teams to develop a project associated with a new application of a semiconductor technology. This will be described in individual reports (2500 words).
There are two individual assignments in which students will reflect upon the personal characteristics, past, present and planned future, associated with the topics of the course (1200 words each)

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students will receive feedback on all assessed work through verbal, written and online media. Students will meet with academic mentors twice during the module to assess their progress, identify challenges and to provide feedback. Students will also seek advice and verbal, written or online feedback from mentor and external contributors to the module to assist in the preparation of their assignment.

Failure Redemption: A suitable supplementary attempt will be permitted on relevant assessment in line with University policy.

Additional Notes: Suitable for exchange students with appropriate backgrounds.

SC-M06 Literature Skills and Review

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof OJ Guy

Format: 20 hours seminars/workshops,
80 hours independent study and preparation for assessment

Delivery Method: All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Delivery in the form of lectures, seminars and individual tutorial sessions.

Module Aims: Students will undertake a literature review project on a state-of-the-art semiconductor technology or technologies. They must make a reasoned choice of journal; then follow the format required by that specified journal and its instructions to prepare a substantial literature survey (up to 5000 words). They will also give a presentation (up to 10 minutes) that discusses the fundamental science behind the technology.

Module Content: • Research skills including database searching
• Writing a literature review
• Writing style
• Storyboard
• Figures and Tables
• Reviewing
• Journal submission process

Intended Learning Outcomes: On completion of this module, students should be able to:

• Examine and critically analyse technical literature and synthesise information
• Write clear and concise reviews and technical papers
• Communicate effectively through oral presentations

Assessment: Written report - Individual (75%)
Presentation (25%)

Assessment Description: Report: Literature survey. Detailed and critical assessment of semiconductor application (max. 5000 words).
Presentation: Individual presentation of 7-10 minutes covering the fundamental science behind the application.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Individual feedback on marked assignments.
Module report.

Failure Redemption: Resubmission of individually assessed coursework in the summer.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.