Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

UNDERGRADUATE STUDENT PROGRAMMES HANDBOOK

YEAR 4 (FHEQ LEVEL 7)

ELECTRONIC AND ELECTRICAL ENGINEERING DEGREE

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 19 September 2022

Full term dates can be found here

DATES OF 22-23 TERMS

19 September 2022 – 16 December 2022

9 January 2023 – 31 March 2023

24 April 2023 – 09 June 2023

SEMESTER 1

19 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 Aerospace, Civil, Electrical, General and Mechanical Engineering **Head of School: Professor Antonio Gil**	
School Education Lead	Professor Cris Arnold
Head of Electronic and Electrical Engineering	Professor Vincent Teng
Electronic and Electrical Engineering Programme Director	Dr Karin Ennser
Year Coordinators	Professor Lijie Li

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/

Supporting Your Studies

- Centre for Academic Success
- Faculty of Science and Engineering- Student Support

Supporting Your Professional Development

As a fourth-year student studying on the *MEng in Electronic and Electrical Engineering* at Swansea University you are continuing a journey which we hope will end with Engineering Council registration as a Chartered Engineer (CEng).

Each of the Integrated Masters (MEng) programmes covered by this handbook has been accredited by the Institution of Engineering and Technology (IET) on behalf of the Engineering Council for the purpose of fully meeting the academic requirement for registration as a Chartered Engineer (CEng).

What this means for you is that the learning outcomes of each year of your programme of study has been carefully designed to align with Version 3 of the Engineering Council's Accreditation of Higher Education Programmes (AHEP) which forms the educational foundation for the UK Standard for Professional Engineering Competence (UK-SPEC).

The knowledge and skills you will have demonstrated by completing your programme of study are defined by achieving a set of learning outcomes distributed across the following key areas of competence:

- Science and mathematics
- Engineering analysis
- Design and innovation
- The engineer and society
- Engineering practice

To find out more about Professional Registration and what the AHEP competences are, please refer to the Engineering Council's Student Guide to Professional Registration and the Accreditation of Higher Education Programmes collated learning outcomes

The IET – Your Professional Home for Life

As a student at Swansea University, you are privileged to be associated with one of the small groups of universities that have been selected to be Academic Partners of the IET. The most tangible benefit of this is that you can register as a student member of the IET at no cost to yourself for the duration of your study. And as a student member of the IET, you can take *full advantage* of the benefits that membership of the IET offers. These include an impressive range of services supporting *Networking*, *Professional Development*, *Learning Resources* and *Membership Benefits*. A summary of these is shown on the Get more from your partnership page.

If you are graduating this year, as an Academic Partner of the IET, the University can offer you access to the IET's Graduate Advantage Scheme: that is, we will pay for your first year of full Membership of the

IET, and you can use the post-nominals MIET straight after graduation for no cost. This will be especially useful as you start to gain and evidence the UK-SPEC competences you will need to complete your IEng or CEng professional registration.

IET on Campus

IET On Campus is designed to support everyone in the Department of Electronic and Electrical Engineering with students at the heart of it. The IET gives you access to tailored practical, technical, and career-related resources and helps you to create links with industry and other universities, building a platform for you to demonstrate your skills and raise your profile. At Swansea, the local branch of IET on Campus is run by the Electrical & Electronic Engineering Society (E&EESoc) and is supported by the IET South Wales Local Network.

For more information, please join E&EESoc and access their social media channels.

IET Student Advisor

Dr Chris Jobling (MIET, CEng) is the *IET Student Advisor* for Swansea University. Please get in touch with him if you want to find out more about the AHEP and UKSPEC, the IET, IET student membership, IET Scholarships, Graduate Advantage, IET Communities, or opportunities to get involved with Wales Southwest Local Network as an IET young professional volunteer. He will be happy to help.

Other members of staff associated with the IET at Swansea include:

- Dr Richard Cobley (MIET)
- Dr Timothy Davies (MIET, CEng)
- Dr Augustine Egwebe (MIET)
- Dr Karin Ennser (MIET, CEng)
- Prof Lijie Li (FIET)
- Mr David Moody (MIET)

UK Electronics Skills Foundation

Swansea University is an academic partner from the UK Electronics Skills Foundation. The partnership means that you can benefit from the UKESF scholarship scheme, competitions, awards and internship programme, which connects the most capable Electronics undergraduates with leading companies in the sector.

UKESF offers opportunities for undergraduates to take advantage of an industry placement, develop their employability skills, generous financial support, and the opportunity to network with professionals in the Electronics sector. Dr Karin Ennser is the *UKESF Student Advisor* for Swansea University. Please contact her if you want to find out more.

Prizes

The following prizes are awarded at the end of the academic year:

- *Institution of Engineering and Technology Prize* – This prize is awarded annually by the IET. The prize will be awarded to the final year undergraduate student on an IET accredited course who, in the opinion of the Board of Examiners, has demonstrated outstanding merit. In the event of insufficient merit being shown the prize will not be awarded.
- *Infineon Prize* – Awarded to the Best MEng group project

Faculty graduation prizes

The Faculty of Science and Engineering awards graduation prizes to the best Electrical and Electronic Engineering student in each graduating year.

Year 4 (FHEQ Level 7) 2022/23
Electronic and Electrical Engineering

MEng Electronic and Electrical Engineering[H606]
MEng Electronic and Electrical Engineering with a Year Abroad[H600]
MEng Electronic and Electrical Engineering with a Year in Industry[H601]

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
EG-M85 **Strategic Project Planning** **10 Credits** **Dr K Wada** **CORE**	**EG-M47** **Business Leadership for Engineers** **10 Credits** **Dr A Munnangi/Dr AS Walters** **CORE**
EGLM00 **Power Semiconductor Devices** **10 Credits** **Prof MR Jennings** **CORE**	**EGLM03** **Modern Control Systems** **10 Credits** **Dr M Monfared** **CORE**
EGLM02 **Advanced Power Electronics and Drives** **10 Credits** **Dr Z Zhou** **CORE**	**EGLM05** **Advanced Power Systems** **10 Credits** **Dr M Fazeli** **CORE**
	EGLM06 **Energy and Power Electronics Laboratory** **10 Credits** **Dr Z Zhou** **CORE**
EG-M121 **Group Project (EEE)** **30 Credits** **Dr KM Ennser** **CORE**	
Total 120 Credits	

Optional Modules

Choose exactly 20 credits
Choose 20 credits from the options below.

AT-M76	Radio and Optical Wireless Communications	Prof L Li/Prof A Mehta	TB1	10 (CORE)
AT-M79	Optical Networks	Dr KM Ennser	TB2	10 (CORE)
AT-M80	Optical Fibre Communications	Dr KM Ennser	TB1	10 (CORE)
EG-M125	Advanced Optical Materials and Devices	Dr WC Tsoi	TB1	10 (CORE)
EGLM01	Wide band-gap Semiconductors	Dr TGG Maffeis/Prof OJ Guy	TB2	10 (CORE)
EGNM01	Probing at the Nanoscale	Dr TGG Maffeis/Prof KS Teng/Dr CJ Wright/..	TB1	10 (CORE)
EGNM04	Nanoscale Structures and Devices	Dr TGG Maffeis/Prof KS Teng	TB2	10 (CORE)
EGNM09	Micro and Nano Electro-Mechanical Systems	Prof L Li	TB2	10 (CORE)

Year 4 (FHEQ Level 7) 2022/23
Electronic and Electrical Engineering
MEng Electronic and Electrical Engineering with a Year Abroad

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
EG-M85 **Strategic Project Planning** **10 Credits** **Dr K Wada** **CORE**	**EG-M47** **Business Leadership for Engineers** **10 Credits** **Dr A Munnangi/Dr AS Walters** **CORE**
EGLM00 **Power Semiconductor Devices** **10 Credits** **Prof MR Jennings** **CORE**	**EGLM03** **Modern Control Systems** **10 Credits** **Dr M Monfared** **CORE**
EGLM02 **Advanced Power Electronics and Drives** **10 Credits** **Dr Z Zhou** **CORE**	**EGLM05** **Advanced Power Systems** **10 Credits** **Dr M Fazeli** **CORE**
	EGLM06 **Energy and Power Electronics Laboratory** **10 Credits** **Dr Z Zhou** **CORE**
EG-M121 **Group Project (EEE)** **30 Credits** **Dr KM Ennser** **CORE**	
Total 120 Credits	

Optional Modules
Choose exactly 20 credits

AT-M76	Radio and Optical Wireless Communications	Prof L Li/Prof A Mehta	TB1	10 (CORE)
AT-M79	Optical Networks	Dr KM Ennser	TB2	10 (CORE)
AT-M80	Optical Fibre Communications	Dr KM Ennser	TB1	10 (CORE)
EG-M125	Advanced Optical Materials and Devices	Dr WC Tsoi	TB1	10 (CORE)
EGLM01	Wide band-gap Semiconductors	Dr TGG Maffeis/Prof OJ Guy	TB2	10 (CORE)
EGNM04	Nanoscale Structures and Devices	Dr TGG Maffeis/Prof KS Teng	TB2	10 (CORE)
EGNM09	Micro and Nano Electro-Mechanical Systems	Prof L Li	TB2	10 (CORE)

AT-M76 Radio and Optical Wireless Communications

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules: AT-M51; AT-M56

Lecturer(s): Prof L Li, Prof A Mehta

Format: Lectures 20 hours; Directed private study 80 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

Examination 90% and continuous assessment 10%

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.

Module Aims: The module reviews linear modulations, channel models for radio wave propagation in wireless communications, and the receiver design principles. The transmission diversity techniques are also included. In the second part, the techniques used in optical wireless communications are explained.

Module Content:

• Point to point wireless communications and linear modulations.

• Propagation models in radio frequency and optical wireless communications.

• Receiver design principles.

• Diversity techniques.

• Performance evaluation.

• Optical wireless techniques.

Intended Learning Outcomes: Technical Outcomes
After completing the module you should be able to:
• Understand transmitter and receiver structure for linear modulations.
• Understand models of radio wave propagation, and how to design the corresponding receiver.
• Understand how to analyze point to point wireless links.
• Understand the principles of optical free-space propagation.
• Understand the components and the design of optical wireless links.

Accreditation Outcomes (AHEP)
-A comprehensive understanding of the relevant scientific principles of the specialisation (Sm1fl)
- Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations (D7m/D2fl)

Assessment: Examination (90%)
Coursework 1 (10%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description:
Coursework 1- 10% students will be divided in week 6 into three groups to survey one of the following topics:
"Use of Optical Wireless as backbone in case of Natural Catastrophes"
"Use of drone-based optical wireless to cover rural areas"
"Optical Satellite Links"
By week 9 each group will present their survey organizing a Powerpoint presentation of 15 minutes made by all member of the group.

Examination: 90% - Answer 3 out of 4 questions

Resit 100% Exam (coursework mark will not be used)

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: During dedicated lecture, via email and during office hours.

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.

• The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment.

• Notes, worked examples and past papers for this module can be found 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.

AT-M79 Optical Networks

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr KM Ennser

Format: Lectures 20 hours; preparation for assignment 30 hours; directly private study 50 hours.

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

A combination of lectures on campus and online teaching material.

A blended learning approach to class contact will be used in which the key concepts and readings will be introduced and understanding tested using online quizzes.

Module Aims: This module presents the essential element of modern optical networking, both in backbone and broadband access scenarios. The module evaluates WDM, the most popular, bandwidth-rich contemporary approach and also others, including optical time multiplexing and photonic packet switching. Relevant telecommunication protocol standards, client layers, and principles of networking design, network dimensioning and planning are covered. Key demonstrators and field hardened trials are presented.

Module Content:

• Client layers of optical layer.

• Network elements and topologies.

• Local, Access and Metro Networks and Data Centres: Architecture and future trends.

• Photonic Packet Switching: Optical time division multiplexing (OTDM), photonic switching node design, broadcast OTDM networks and testbeds.

• Testbed examples.

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

• Understand different client layers and relevant standards.
• Evaluate different WDM network elements and topologies including broadcast-and-select and wavelength routing networks.
• Understand and design of optical local, access and metro networks.
• Analyse photonic packet switching networks and time-domain optical networking approaches.
• Appraise the evolution of modern optical networks through the assessment of key network demonstrators and field implementations.

Accreditation Outcomes (AHEP):
EA2fl Ability to use fundamental knowledge to investigate new and emerging technologies.
EA3fl Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of
engineering analytical methods.
D1m Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics.
D2m Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards.
D1fl 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.
ET2fl Awareness that engineers need to take account of the commercial and social contexts in which they operate,
ET5fl Awareness of relevant regulatory requirements governing engineering activities in the context of the particular specialisation,
EP4m Understanding of the use of technical literature and other information sources
EP2fl A thorough understanding of current practice and its limitations, and some appreciation of likely new developments

Assessment:	Examination (60%) Group Work - Presentation (20%) Assignment 1 (10%) Assignment 2 (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: The module is based on Examination (60%) and Continuous Assessments (40%).

The Group Work - Presentation (20%) is a group activity and it consists of delivering a short report and a presentation on a given topic on optical networking. The individual assignments consists of two online quizzes (each 10%)

Zero Tolerance Penalty for late submission of Continuous Assessment. Late submissions are given Zero (0%) mark.

• 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: The feedback is provided during lectures whenever possible or during office opening hours.

Failure Redemption: If rules allow - standard University provision with marks capped. Failure Redemption of this module will be by 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 to Visiting and Exchange students.

• Notes, worked examples and past papers for this module can be found on Canvas.

• The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment.

• 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.

AT-M80 Optical Fibre Communications

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr KM Ennser

Format: On-demand lecture materials: 20 hours;
Live Discussion & Examples Classes: 10 hours;
Directed Private Study: 70 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

A blended learning approach to class contact will be used in which the key concepts and readings will be introduced and understanding tested using online quizzes.

The live classes will focus on discussions and examples classes (one hour per week). Live teaching sessions will be reinforced by making worked solutions available after class.

Each week will require around 2-3 hours of student engagement to review all the on-demand materials, complete the formative assessments and engage in class discussions.

Module Aims: This module is devoted to the technology underlying optical fibre communication systems. It covers the fundamental properties of optical fibres and key components, and the principles of operation of systems including WDM based high capacity transport networks. The network architecture designs and performance metrics are examined. Modern topics are introduced such as advanced modulation formats, coherent communications, spectrum efficiency and Shannon limit capacity.

Module Content:

• Introduction to optical fibre technology

• Enabling technologies: Laser sources and filters, couplers, isolators, circulators, optical multiplexers, optical amplifiers, dispersion compensators.

• Transmission systems: crosstalk, dispersion, fibre nonlinearities, noise and system sensitivity, link power budget, repeater spacing.

• Wavelength division multiplexing (WDM) systems and key components.

• WDM amplifier and system design, coherent detection and polarisation multiplexing.

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

* Understand the fundamentals of optical fibre technology and their implications in optical fibre communications
* Appraise key components and their technologies that enable modern optical networks
* Design optical transmission systems for different architecture scenarios
* Evaluate transmission performance and apply quantitative and qualitative metrics

The following AHEP 3 Programme Learning outcomes at Partial CEng (Further learning) (fl) and CEng (m) are partially addressed at a threshold level by this module:

* Ability to use fundamental knowledge to investigate new and emerging technologies including optical communications WDM channels digital optical signals and systems, optical propagation and waveguides (fibres), modulation and coding techniques of optical signal including phase and multilevel, organisation and operation of optical communications networks, optical network architectures and noise in amplified optical communications systems. (EA5m, EA2fl assessed by coursework and exam)

*Ability to apply a systematic approach to the analysis and design of optical communication links taking into account technical constraints such as crosstalk, dispersion, fibre nonlinearities and noises. (EA6m, EA3fl, assessed by coursework and exam)

* Ability to apply a systematic approach to the analysis and design of optical communication links taking into account health, safety and environmental issues, the cost versus performance trade-off, International Telecommunications Union (ITU) standards and social-economical issues. (D2m assessed by coursework and exam)

* Ability to apply several quantitative and qualitative metrics (eg, eye-diagram, Q factor, bit error rate, optical signal-to-noise ratio, amplifier noise figure) in the analysis of network performance and design. (D3m, D1fl, assessed by coursework and exam)

*Appreciation of technology choices based on cost, capacity and demand in the context of optical fibre telecommunication. Understanding the different requirements in local access, metropolitan area, terrestrial high capacity networks and submarine links. (ET2m, ET2fl, assessed by coursework and exam).

*Knowledge of relevant legal and contractual issues (EP5m)

* A thorough understanding of current practice in the key components and their configurations in high speed optical (WDM) systems including different fibre types, amplifiers, multiplexers and compensators. (EP9m, EP2fl, assessed by coursework and exam)

*Cost and commercial constraints on system design, e.g. why amplifier spacing is maximised, access network architecture. Commercial long-distance system design and installation are presented and discussed the requirements and constraints, such as the use of solar panels to feed equipment in a desert area, positioning of the nodes due to geographic limitations (EP10m, EP2fl, assessed by coursework and exam)

Assessment:	Exam - open book (70%) Coursework 1 (5%) Coursework 2 (5%) Coursework 3 (5%) Coursework 4 (5%) Group Work - Coursework (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: The module is assessed by an exam (70%), four pieces of coursework (20%) and a group design case study (10%). The four pieces of coursework are a mix of written assignments and online quizzes.

Zero tolerance for a late submission.

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: The students receive feedback on the coursework during lectures and via Canvas.
Failure Redemption: If rules allow - standard University provision with marks capped. Failure Redemption will be by Examination.
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of coursework and continuous assessment. 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.

EG-M121 Group Project (EEE)

Credits: 30 Session: 2022/23 September-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr KM Ennser

Format: Group allocation and team building at start of the project followed by practical sessions group and individual work, meetings with Industrialists as arranged. Each team should meet the academic supervisor at least 6 times per semester.
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

Project briefing (academic supervisor), group meetings, project plan statement, project progress presentation, final report writing, poster and viva presentations, and interview sessions.

After the team and project allocation, there will be an initial discussion with the academic and/or industrial supervisors. Students will be in direct contact with the supervisors as appropriate. Thereafter, regular group meetings will be arranged typically biweekly during the term time. The project progression will be made in accordance with the project requirements and guideline. Details on the project deliverables with respective submission deadline will be announced by the module coordinator at the project briefing session and via Canvas.

Module Aims: This module enables students to participate in a group activity involving a multi-disciplinary approach to achieve a solution to a specific design problem. In most instances it will involve either direct interaction with industry or will be an industrially-related project. Issues other than providing a purely technical solution to the problem will have to be considered in order to achieve a satisfactory outcome to the project.

Module Content: Formulating a full design specification that meets all the likely requirements throughout the working life of the 'product' or 'system'. Consideration of aspects such as material selection, hardware/software technologies, failure and risk, safety and environmental impact, sustainability, health and safety, maintenance and serviceability, also fitness for purpose and cost implications. Production of a construction/manufacturing/assembly/integration/testing strategy. Socio-economic considerations and business plan.

Intended Learning Outcomes: The AHEP 3 Programme Learning outcomes at Full CEng (m) are addressed at a threshold level by this module:

The learning outcomes are assessed by a combination of continuous assessments.
SM1m 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.
SM2m Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply a range of mathematical and statistical methods, tools and notations
proficiently and critically in the analysis and solution of engineering problems.
SM3m Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively.
SM4m Awareness of developing technologies related to own specialisation
SM6m Understanding of concepts from a range of areas including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects.
EA1m Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes.
EA3m 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.
EA4m Understanding of, and the ability to apply, an integrated or systems approach to solving complex engineering problems.
EA5m Ability to use fundamental knowledge to investigate new and emerging technologies.
D1m Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics.
D2m Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards.
ET2m Knowledge and understanding of the commercial, economic and social context of engineering processes,
ET3m Knowledge and understanding of management techniques, including project and change management, that may be used to achieve engineering learning outcomes, their limitations and how they may be applied appropriately,
ET7m Understanding of the key drivers for business success, including innovation, calculated commercial risks and customer satisfaction.
EP9m A thorough understanding of current practice and its limitations, and some appreciation of likely new developments
EP10m Ability to apply engineering techniques taking account of a range of commercial and industrial constraints
EP11m 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.

Assessment: Group Work - Project (60%)
Portfolio (40%)

Assessment Description:
Assessment will be, as a baseline, 60% for the group and 40% for the individual's contribution to the group.

40% Portfolio - Individual contribution to the project will be assessed on the basis of a) contribution to project progress, b) 'time management' project leader reports, and c) end-of-term presentations and interviewing the team members individually to check on each student's contributions to the project, and adopting the peer-review assessment to moderate the group mark.

The full breakdown of marks will be provided by the module coordinators at the start of Semester 1.

Moderation approach to main assessment: Universal non-blind double marking

Assessment Feedback:
Feedback will be given by supervisors as regular part of meetings with students. Formal verbal/written feedback will be provided on the assessed parts of the project.

Failure Redemption: There is no failure redemption for this module. Failure in this module would normally result in an exit qualification due to insufficient credits having been attained.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.
The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment.
NOT AVAILABLE to visiting and exchange students.
Generic information and project-specific information will be posted on Canvas.

EG-M125 Advanced Optical Materials and Devices

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr WC Tsoi

Format: 11 weeks, each week 2 hours lecture (+demonstration if possible) + 1 hour example class (+Lab tour if possible)

Both will be online, with a possibility of limited on-site sessions.
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, example classes, experimental demonstrations if possible, lab tours if possible.

Module Aims: This module covers advanced printable semiconducting materials for optical devices, with particular focus on their applications for new type of photovoltaic cells and light emitting diodes, and the working principles and engineering of the devices.

Module Content: • Introduction to semiconductors
• Introduction to organic semiconductors
• Introduction to perovskite semiconductors
• Organic and perovskite photovoltaic devices
• Organic and perovskite light emitting diodes
• Light absorption and excitons
• Charge separation and recombination
• Charge transport and injection
• Electroluminescence and outcoupling

Intended Learning Outcomes: After completing this module, students should be able to:
• Define what are organic and perovskite semiconductors
• Identify and describe their optical and electrical properties
• Understand their applications, working principles and engineering for photovoltaic devices and light emitting diodes
• Know the facilities to fabricate and test photovoltaic devices and light emitting diodes

Accreditation Outcomes (AHEP)
- Awareness of developing technologies related to own specialisation (SM4m / SM2fl)
- A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations (SM5m)
- Ability to use fundamental knowledge to investigate new and emerging technologies (EA5m / EA2fl)

Assessment: Assignment 1 (15%)
Assignment 2 (10%)
Examination (75%)

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

Assessment Description: 15% Assignment one: online multiple choices test
10% Assignment two: online multiple choices test
75% Exam: Open book

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

Assessment Feedback: The assignments will be marked by the Canvas system immediately after the submissions. The statistics of the performance and the solutions to the questions will be provided shortly after each assignment. Furthermore, oral clarification of issues is available at student¿s request.
Feedback on the written examination will be in a standard format on the Faculty Intranet. Information provided includes average mark, maximum and minimum marks, for the examination as a whole and for individual questions. Besides, the common mistakes for each question will be provided, with suggestions on how to improve.

Failure Redemption: Resit in August: This supplementary examination is based on a written examination only, which is worth 100% of the total module mark.

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

Available for Visiting and Exchange Students
PENALTY: ZERO TOLERANCE FOR LATE SUBMISSION.

EG-M47 Business Leadership for Engineers

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr A Munnangi, Dr AS Walters

Format: Lectures/Workshops - 22 hours
Open door tutorials/workshops - 8 hours
Directed private study 70 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

Combination of interactive lectures/workshops/case studies and self-study.

Module Aims: At the end of this course students will be able to recognise and understand key characteristics of leadership as well as a wide range of strategic business skills, ideas and theories with emphasis on innovation and "entrepreneurial thinking" which is essential for the current multidisciplinary engineering environment. The course delivery integrates practical project work and academic rigour.

Module Content: Workshop 1 – Introduction & Leadership Part 1
Workshop 2 – Leadership Part 2
Workshop 3 – Team Formation, Development and Communication
Workshop 4 - Entrepreneurial Thinking
Workshop 5 – Change Management
Workshop 6 – Strategic Management
Workshop 7 – Innovation and Business Thinking, Group Assignment Part 1
Workshop 8 – Innovation and Business Thinking, Group Assignment Part 2
Workshop 9 – Group Assignment Workshop
Workshop 10 – Group Assignment Workshop

Intended Learning Outcomes:
Technical Outcomes
On successful completion of this module students will be expected, at threshold level, to be:
- Demonstrate an understanding of current leadership issues. Critically appraise theories and approaches to leadership and at the same time reflect on personal leadership aspects.
- Knowledge to assess the basic factors that must be considered for a business formation. Use of basic level strategy and innovation methods in order for an organisation to gain competitive advantage. Critically evaluate the rationale for utilising methods for idea generation/innovation.
- Have awareness of theoretical perspectives and approaches to change management in organisational environments. Synthesise the relationship between the external context of an organisation and its internal context and their impact on its strategic direction.
- Demonstrate and appraise, entrepreneurial way of working, team development and communication skills

Accreditation Outcomes (AHEP)

- Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards (D2)
- Demonstrate the ability to generate an innovative design for products, systems, components or processes to fulfil new needs (D8m)
- Knowledge and understanding of management and business practices, their limitations, and how these may be applied in the context of the particular specialisation, (ET3fl)
- Awareness that engineering activities should promote sustainable development and ability to apply quantitative techniques where appropriate, (ET4fl)
- Awareness of and ability to make general evaluations of risk issues in the context of the particular specialisation, including health & safety, environmental and commercial risk. (ET6fl)
- Understanding of the key drivers for business success, including innovation, calculated commercial risks and customer satisfaction. (ET7m)

Assessment:	Group Work - Coursework (80%) Online Class Test (10%) Online Class Test (10%)
Resit Assessment:	Coursework reassessment instrument (100%)

Assessment Description: Online Test 1 Assessment level marking - PGTM March 10%
Online Test 2 Assessment level marking - PGTM March 10%
Group Work Coursework Assessment level marking - PGTM April 80%

The group (5/6) assignment will require application of the "key skills" and innovation development tools to generate solutions for real-world scenarios – report (40 pages) and development of Business Canvas.

This module is assessed by a combination of group-based and individual assignments (quiz-1 and quiz-2). In the main exam, the marks students get in quiz -1 and quiz-2 will add to the marks the individual gets in the group assignment project. For the resit exam, the quiz-1 and quiz-2 marks will not add to the project.

Moderation approach to main assessment: Partial second marking

Assessment Feedback:
Continuous group feedback on "out-comes" of workshops, after submission of coursework 1 at request during open-tutorials.

Failure Redemption:
Exam resits according to University regulations.
100% coursework.

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

The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment

Related assignments are used to assess this module.

This module is assessed by a combination of group-based and individual assignments. In order for the individual assessment marks to count, you must achieve at least 40% in the group-based assignment. If you achieve less than 40% in the group-based assignment, then the module mark will be just the group-based assignment mark.

EG-M85 Strategic Project Planning

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr K Wada

Format: Lectures and Case Studies 13-15 hours; Project Monitoring 7 hours (project briefing, project update and presentations); Private Study 78-80 hours (reading, group work, exam preparation)
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

Series of lectures and combination of case study, project briefing/update and group work sessions.
Practical group work sessions (50%) will be arranged in order to grasp the project management techniques and effectively apply them to form a 'High Performance Team'. This coursework assessment (CA) is comprised of a group project and group presentation.
Examination - Closed Book (50%) at the end of the semester.

Module Aims: This module has been accredited by the professional body - the Association for Project Management (APM). At the end of this course students will be able to recognise and define the key characteristics and components of a project, understand the advantages/disadvantages associated with the management of both small and large projects, and have an appreciation of the strategic tools and techniques available to enable effective or efficient project management leading to a 'High Performance Team'. The acquired skills will be reinforced by the completion of a group project to produce an initial feasibility report (e.g. a business case/project management plan document) for a major regional project.

Module Content: 1) Lectures: series of lectures will be conducted and/or recorded to cover the fundamentals of strategy and project management. Various tools and techniques used by a project manager at large in the industry will be demonstrated with figures/diagrams/tables/videos and further elaborated through relevant examples.
Intended coverage of syllabus (as recommended by APM):
1. Structure of organisations and projects
2. Project life cycle
3. Project contexts and environments
4. Governance and structured methodologies
5. Communication
6. Leadership and teamwork
7. Planning for success
8. Scope management
9. Schedule and resource management
10. Procurement
11. Project risk management and issue management
12. Project quality management

2) Case study/Webinar: internal/external guest speaker(s) will be invited to give talks on some of the topics on project management, an hour session each.

3) Project briefing and update: information on CA (including but not limited to project titles, group allocation, project manager/assistant manager nominations, marking scheme, report format, and presentation arrangement) will be announced during these sessions. Frequently asked questions (FAQs) will be answered in the meantime.

4) Group work and Presentation: dedicated hours will be provided for the group work (i.e. dealing with CA task). No lectures during these sessions. With regard to CA, dedicated time slots will be arranged for the final presentation.

Intended Learning Outcomes: Technical Outcomes
On successful completion of this module students will be expected, at threshold level, to be able to:
- Demonstrate a comprehensive knowledge and understanding of project management - the nature of both small and large projects, the issues and constraints such as environmental and sustainability limitations; ethical, legal, health, safety, security and risk issues; the tools available to manage the project - and critically evaluate them and apply the tools effectively in projects to communicate the outputs to technical and non-technical audiences. (Assessed by Coursework report, Presentation and Exam; or Resit Exam)
- Use fundamental knowledge to investigate new and emerging technologies via application of strategy such as PESTLE analysis, SWOT analysis and Porter's generic strategies as a means not only to understand the key drivers for business success pertaining to the commercial, economic and social context of engineering processes, but also to identify, compare and evaluate competitive advantage, cost leadership, differentiated product/services, or niche markets. (Assessed by Coursework report, Presentation and Exam; or Resit Exam)
- Have awareness of relevant legal and contractual issues, as well as quality issues and their application to continuous improvement (i.e. quality planning, quality assurance, quality control and continuous improvement). This requires the demonstration of knowledge, interpretation and application of project management theory and practice. (Assessed by Coursework report, Presentation and Exam; or Resit Exam)
- Demonstrate a comprehensive knowledge and understanding of the role of a project manager - an ability to exercise initiative and personal responsibility: i) understand the team members' characteristic and their needs; ii) delegate project activities and find ways to resolve conflicts through effective communication to build a 'High Performance Team'; and iii) understand and evaluate business, customer and user needs. (Assessed by Coursework report, Presentation and/or Resit Exam)

Accreditation Outcomes (AHEP)
- Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards (D2)
- Communicate their work to technical and non-technical audiences (D6)
- Awareness that engineers need to take account of the commercial and social contexts in which they operate (ET2fl)
- Knowledge and understanding of management and business practices, their limitations, and how these may be applied in the context of the particular specialisation (ET3fl)
- 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)
- Ability to apply engineering techniques, taking account of a range of commercial and industrial 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 (50%)
Coursework 1 (50%)

Assessment Description: Coursework 1 is a group project allocated during the lecture series. Examination 1 is a standard closed book examination.

The pass mark for a module at Year 4/M is 50%. In addition to this, students must also achieve at least 40% in both components to pass this module.

If you do not meet the component level requirements for the module you will receive a QF outcome. This means that you will be required to repeat the failed component(s), even if your module mark is above 50%.

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

Assessment Feedback: Informal feedback is given during lectures, project briefing/update sessions, group presentations, and at group work meetings. Formal feedback is given via standard College of Engineering feedback protocols.

Failure Redemption: Failure Redemption of this module will be by repeating an equivalent coursework and/or exam to any component in which a pass mark was not achieved.

Marks achieved in assessment component passed during the first attempt will automatically be transferred to the equivalent component in the resit.

No opportunity to resit the passed component.

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

Penalty for late submission of work: ZERO TOLERANCE.
Available to visiting and exchange students wishing to enhance project management skills.

The pass mark for a module at Year 4/M is 50%. In addition to this, students must also achieve at least 40% in both components to pass this module.

Office hours, lecture notes and other teaching materials and notifications will be posted on Canvas.

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.

EGLM03 Modern Control Systems

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr M Monfared

Format: On-campus: examples and problem solving: 20 hours;
Support for modelling and design exercises: 10 hours;

Delivery Method: A blended learning approach to class contact will be used in which the key concepts and readings will be introduced
and understanding tested using on-demand readings, short lectures and concept reinforcement quizzes before each live class event.

This leaves time to practice the mathematical techniques that are causing the most difficulties during the class contact time (two hours per week).

Live teaching sessions will be reinforced by making worked solutions available after class.

Each week will require around 2-3 hours of student engagement to review all the on-demand materials, complete the formative assessments and engage in class discussions.

An online textbook will be available and OneNote Class Notebook will be used as a class notes and handouts delivery platform, shared whiteboard and host for discussion and worked examples. In addition, there will be PC lab-based laboratory sessions used to introduce MATLAB, the Control System Toolbox and modelling and simulation in Simulink. A modelling exercise (performed in pair) and a design exercise (performed in groups of 4-5) will provide hands-on experience of the application of the design approaches covered in class. Provision will be made to ensure that the practical exercises can be completed even if social distancing is in place. This will be supported by around 10 hours of lab support - in class or via Zoom.

The course will be designed "online first" so that the learning outcomes will be achieved even if completely online delivery is needed. This can easily be adjusted to adapt to a blended delivery with variable amounts of on-campus teaching.

Module Aims: This module introduces ideas in modern control systems and their applications.

Module Content: This module will be focused on the study of a particular control problem:
• Modelling: single-input single-output (SISO) systems, revision of transfer functions, state-space modelling, nonlinear systems, multiple-input-multiple-output (MIM0) systems.
• Simulation: simulation as a design tool, continuous systems simulation, discrete event systems, simulation of digital systems, simulation of mixed continuous and discrete systems.
• Design: Control system performance specification and achievement of performance specification by dynamic compensation.
• Digital systems and the z-transform. Digital compensation: digital to continuous equivalence, direct digital design.
• State-space methods: modelling, transformations, pole-placement methods of control, construction and use of observers. The Linear Quadratic Regulator.
• Applications (study for project work): motor drives, mechatronics, aerospace flight control, process monitoring and control.

Intended Learning Outcomes: Technical Outcomes
At the end of the course you should be able to:
• Model a system in the electrical engineering domain and run simulations.
• Analyse the linearized models for such systems and devise a control strategy based on conventional or state-space methods.
• Implement such control systems as digital controllers.

The following AHEP 3 Programme Learning outcomes at C.Eng (m) and Partial C.Eng by Further Learning (fl) are partially addressed by this module:
Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply a range of mathematical and statistical methods, tools and notations proficiently and critically in the analysis and solution of engineering problems. (SM2m)
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)
Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods (EA3fl)
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)
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 (70%)
Coursework 1 (10%)
Coursework 2 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description:
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.

There are three assignments for this course:

* Coursework 1 is a Simulink Modelling Exercise to be done in pairs. 10% of the marks will be for this component.
* Coursework 2 is a Control Systems Design Exercise to be tackled in groups of 4-5 using Matlab, the Control Systems, Toolbox and Simulink assessed by the submission of an executive summary report. 20% of the marks will be for this component.

The June Examination will be a parameterized personalized paper consisting of one compulsory question and 2 questions from the remaining 3. There will be 25 marks per question. Questions 2-4 will contain an open-ended element (5 marks) requiring a demonstration of design thinking. If an alternative assessment is required, this paper will be delivered as an open book examination and all questions will need to be answered.

The exam is worth 70% of the module marks.

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

Assessment Feedback: In-class feedback is used throughout the course both with audience response systems and PostIt notes for queries and questions. There is also a discussion board on Canvas and in Teams that can be used to elicit information from the lecturer. Feedback on the modeling exercise is done using video screencasting supported by the Rubric Tool and the individual feedback feature of the Canvas SpeedGrader. Feedback on the Group Design Exercise is via Canvas and makes use of the rubric tool and the SpeedGrader individual feedback feature. Feedback on the examination is via the standard engineering examination feedback form which will be posted on Canvas. The Canvas announcement and discussion tools are used for general feedback on all aspects of the formal and informal feedback for the module.

Failure Redemption: If permitted within the regulations, a 100% resit examination will be offered to students.

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.

• AVAILABLE TO visiting and exchange students.
• This module makes full use of the e-learning support tools provided by Canvas, Teams and the OneNote Class Notebook.
• The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of coursework and continuous assessment.

EGLM05 Advanced Power Systems

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules: EG 241; EG 342

Co-requisite Modules:

Lecturer(s): Dr M Fazeli

Format: Lecture: 24-26 Hours
Example class: 6 Hours
Private study: at least 70 hours

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

Classroom sessions (lectures, interactive discussions and examples classes)
100% examination.

Module Aims: This module will study Power Networks control including active power-frequency control, voltage-reactive power control and fault analysis. Integration of Renewable resources (including wind and solar) within the grid will be also discussed, which leads to the introduction of of distributed generation, microgrids and smart grids.

Module Content: • Introduction: Synchronous generators, Per Unit calculations.
• Symmetrical component and faults calculation.
• Protection systems in a power network.
• Stability studies.
• Voltage and frequency control.
• Integration of renewable generation, challenges and opportunities.

Intended Learning Outcomes: Technical Outcomes
On successful completion of this module students will be expected, at threshold level, to be able to:
• Evaluate rotor angle stability using Swing Equation and Equal Area Criterion, which demonstrates a comprehensive knowledge and understanding of power system stability (assessed by exam).
• Design the control system for a current-controlled voltage source converter in different operating modes, which demonstrates awareness of developing technologies in renewable energy control (assessed by exam).
• Evaluate the performance of different substation layouts, which demonstrates understanding of engineering principles (assessed by exam).
• Propose appropriate protection system for different components and applications in power systems, which demonstrates the ability to identify, classify and describe the performance of different protection relays (assessed by exam).
• Evaluate and explain different methods of controlling/supporting voltage and frequency, and apply economic dispatch criterion in a power systems, which demonstrate knowledge and understanding of commercial and economic context of engineering processes.

Accreditation Outcomes (AHEP)
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 to use fundamental knowledge to investigate new and emerging technologies (EA2fl)
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)

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

Assessment Description:
Examination (100%)

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

Assessment Feedback: Feedback will be given to the class after the examinations on the standard Faculty Examination Summary Sheet.

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 makes full use of the e-learning support tools provided by Canvas.

• The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of coursework and continuous assessment.

EGLM06 Energy and Power Electronics Laboratory

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr Z Zhou

Format: On-demand 22 hours of online simulation labs
Directed private study 78 hours

Contact Hours will be delivered through a blend of live activities online and may include, for example, lectures, simulation classes, seminars 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.

Assessment: 100% Continuous Assessment.
Laboratory work: 22 hours
Directed private study: 78 hours

Module Aims: The module covers main aspects of Engineering Applications for the MSc students in electrical & electronics engineering. It includes preparation, performance and reporting on a structured series of simulation supporting the taught modules at this level and gives the simulation experience of power electronics converters, electrical machine and photovoltaic (PV) system operation, practice in using simulation software and IT packages to assist with the laboratory work and report writing.

Module Content: • Photovoltaic system electrical characteristics.
• Maximum power point tracking method for PV system
• Power electronics converter and control for PV system
• Design and development of simulation circuit of solar energy-based battery charging systems
• Single-phase induction machine operation and starting techniques.

Work includes:
• The preparation for the simulation labs.
• The use of software tools for system design and simulation.
• Construction of simulation circuits for a PV system and electrical machine.
• Information recording and analysis.
• Practice in using IT packages to assist with report writing and presentations.

Intended Learning Outcomes: Technical Outcomes,
After completing this module, you should be able to:

• Design and develop simulation circuit of power electronics converter circuit and controller for photovoltaic (PV) energy storage systems.
• Design maximum power point tracking algorithm (MPPT) for PV systems
• Specify the parameters of the passive components for power electronics converters.
• Analyse the electrical characteristics and starting performance of the single-phase induction machine.

The following AHEP 3 Programme Learning outcomes are partially addressed by this module:

• A comprehensive understanding of the relevant scientific principles of the specialisation (SM1fl)
• 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 to use fundamental knowledge to investigate new and emerging technology (EA2fl)
• Understanding of, and the ability to apply, an integrated or systems approach to solving complex engineering problems (EA4m)
• 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)

Assessment: Assignment 1 (60%)
Assignment 2 (40%)
Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description:
Students need to submit a simulation lab report for each continuous assignment. The first continuous assignment (A1) is worth 60%, the second assignment (A2) is worth 40%.

This module is delivered by a combination of A1 and A2. In order for the A2 marks to count, you must achieve at least 40% A1. If you achieve less than 40% in A1, then the module mark will be just the mark from A1.

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

Assessment Feedback: Students will receive feedback from the module lecturer and demonstrator during the designate feedback session.

Failure Redemption: Failure redemption of this module will be by resit continuous assignment in August (100%). The failure redemption is only available to students who record sufficient engagement (80% lab attendance, attendance at scheduled online or lab events).

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

AVAILABLE TO a limited number of Visiting and Exchange Students due to number restriction.

LABORATORY (simulation) CLASSES ARE COMPULSORY. Students must have at least 80% attendance at laboratory classes in order to be allowed to be assessed for the module.

The Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment.

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.

EGNM04 Nanoscale Structures and Devices

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

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

Format: Lectures/on demand activities: 20 hours;
Laboratory: 2 hours;
Directed private study: 40 hours
preparation for assessment: 40 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/Laboratory/Example classes/Discussions

Module Aims: This module explores the novel properties of semiconductors and metals when their dimension reach the nanometre scale. The module reviews various types of nanostructures (nanowires, quantum dots, graphene, carbon nanotubes) focussing on fabrication techniques, properties and practical applications. It also details the challenges faced by the Silicon industry beyond Moore's law and highlights possible replacements for CMOS technology.

Module Content:

• Micro and Nano-electronics - Top-down technology examining scaling issues, lithography and beyond. Real devices: transistors and others (FinFet, latest node). Next generation devices (Single electron transistor, nanowires, quantum computing)

• Bottom-up Technology - Atomic manipulation and Quantum Corrals. Growth techniques for nanostructures (chemical and physical vapour deposition, molecular beam epitaxy) - Nanolithography and next generation devices.

• Nanoscale Structures - Nanowires, Quantum Dots, Bucky balls and Carbon Nanotubes: their physical and electronic properties, fabrication and applications.

Intended Learning Outcomes: Technical outcomes:
• Demonstrate an advanced knowledge of nanoscale objects and devices and their novel properties compared to bulk counterparts
• Critically describe the top-down and bottom-up approaches for the fabrication of nanostructures, their advantages, applications and limitations.
• Explains the physical implications of nanoscale objects for real and next-generation devices.
• Analyse and critically review information resources (journals, internet, talks, etc.).
• Understand physical, chemical and biological concepts and how they apply to nanotechnology.
• Conduct, analyse and document experiments with minimum help.
• Apply statistical analysis to experimental data.
• Research and present a chosen topic professionally.
• Evaluate specific experimental results or research papers and place them in a wider context.

Accreditation outcomes (AHEP):
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)
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 to use fundamental knowledge to investigate new and emerging technologies. (Ea2fl)
Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of
engineering analytical methods. (EA3fl)
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)

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

Assessment Description:
Exam: a mix of numerical problems and open ended questions
Lab report: written in the form of a publication.
Presentation: 10 minutes and 5 minutes of questions based on a selected publication.

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: Feedback provided on the feedback form

Failure Redemption: If rules allow a 100% supplementary examination with marks capped.

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

• Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

• Practical work: Growth of nanostructures; nanostructures studied by SEM.

• All lectures and course material will be provided on Canvas.

• Not available to Visiting and Exchange students due to lab activity.

• 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.