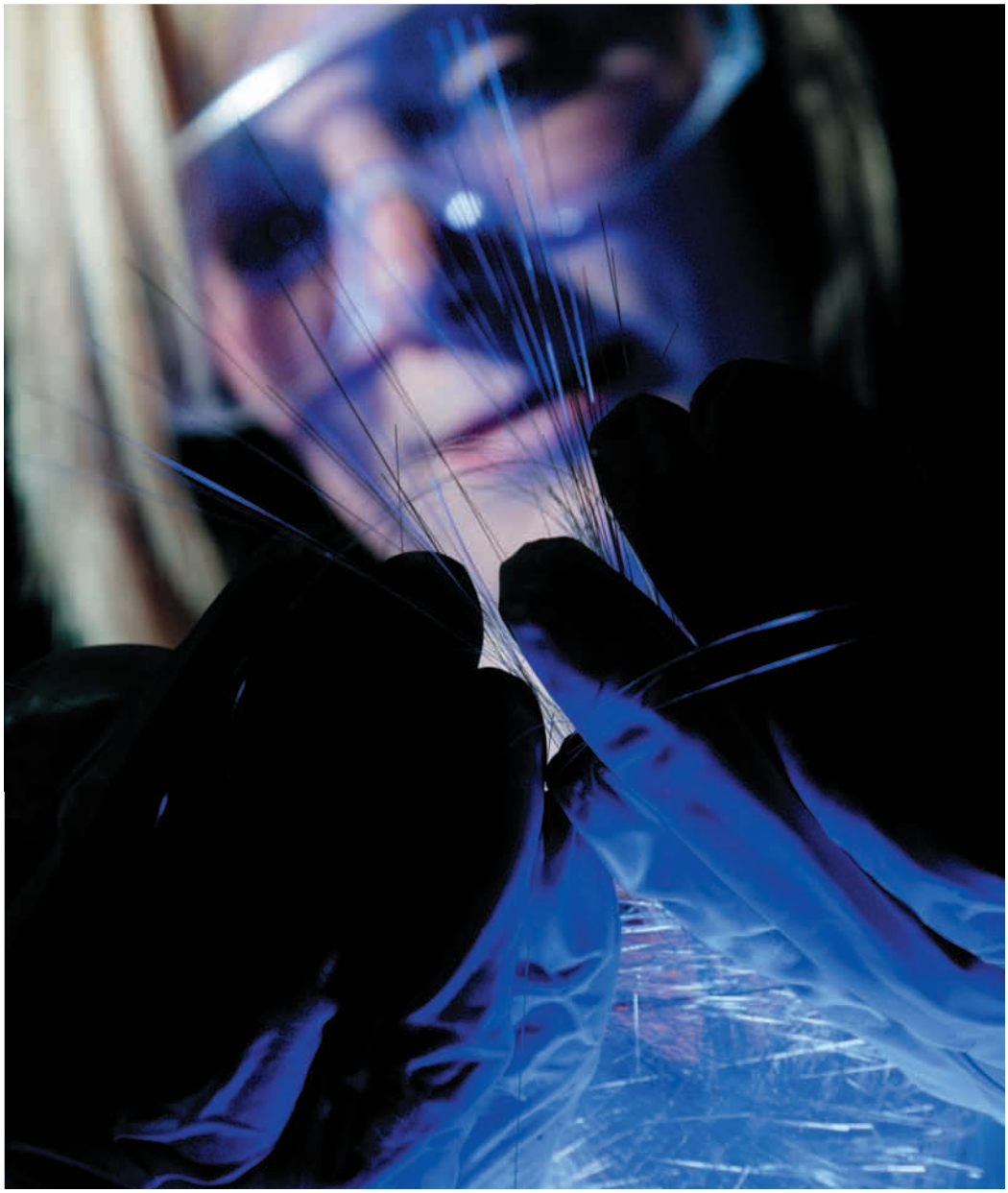
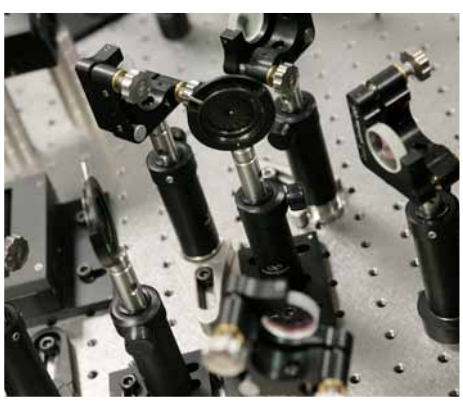
School of Electronic and Electrical Engineering

FACULTY OF ENGINEERING

UNIVERSITY OF LEEDS

Postgraduate Masters Courses





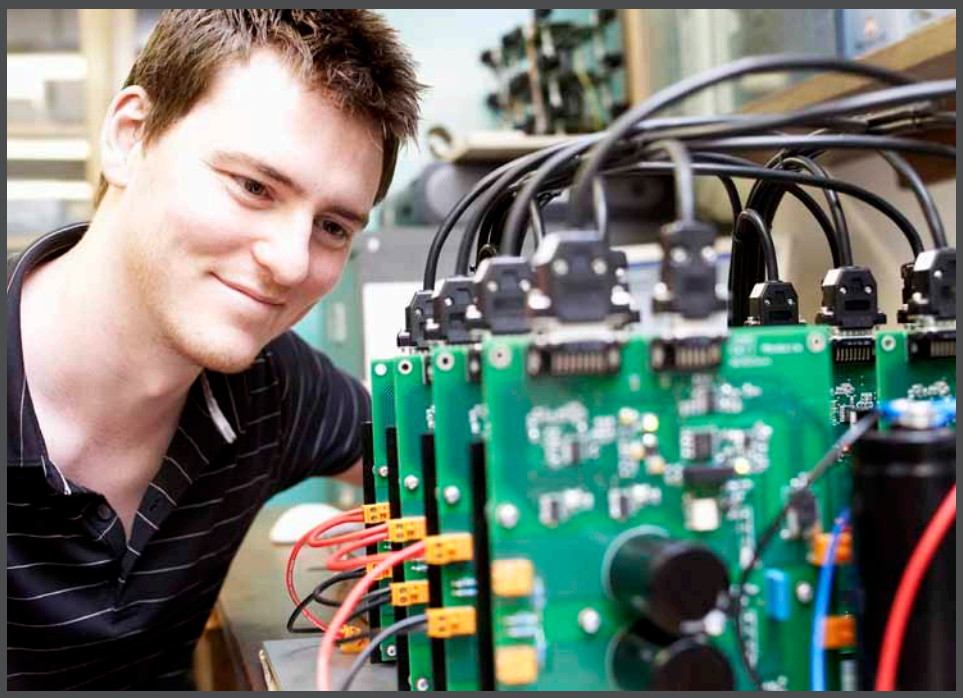
Contents

For current information on courses, fees and entry requirements please visit our website at **www.engineering.leeds.ac.uk/electronic/postgraduate**

School of Electronic and Electrical Engineering

Originally founded in 1898, the School of Electronic and Electrical Engineering rapidly established an international reputation for excellence in both teaching and research.

Over one hundred years later, the School continues to lead the way. This is underlined by high ratings for both teaching and research. In the latest UK Government Research Assessment Exercise (RAE), the School is ranked number 1 in the UK with an impressive 80% of research activity rated as internationally excellent or world leading.



These high ratings enable the School to attract the best staff and to invest in excellent facilities. This wealth of expertise and investment ensures that you receive the best quality of education.

As a research-led School, our core philosophy is to ensure that top quality research informs and enhances the learning and teaching experience. Our research activities are extremely well funded with an annual research expenditure of over £6 million. With 50 academic staff and over 400 students from around the world we are also one of the UK's largest (research-led) Electronic and Electrical Engineering schools.

So we welcome the very best postgraduate students from around the globe, and while our standards are very high, if you think that you might be up to the challenge then we encourage you to join us here at Leeds. Our masters courses will allow you to further your knowledge, widen your skills base and improve your career prospects. They are also excellent preparation for those individuals wishing to undertake further, in-depth study in the form of a PhD.

www.engineering.leeds.ac.uk/electronic

Why choose us?

Research intensive

Our MSc courses are delivered by academic staff who are research active and have extensive knowledge and expertise accumulated over time, many of whom are leading experts in their chosen fields of specialisation. Our research feeds directly into our teaching, which means you'll learn about the latest developments within your field from world-class academics who will challenge, encourage and support you.

First-class facilities

As you'd expect of a top-rated UK research school, with over one hundred postgraduate students from across the world, facilities for postgraduate study are of the highest standard. Our School is purpose built, self-contained, and offers a pleasant and friendly environment for study, with central University facilities just a few minutes' walk away.

We have an enviable array of multi-million pound research laboratories equipped with cutting edge technology. Major investment has been made in new facilities in the areas of high frequency and wireless communications. The RF and microwave facilities include a range of network analysers operating to 325 GHz; wafer probing, RF and microwave circuit laser prototyping, ceramic circuit fabrication equipment and six digital modulation workstations for the generation and analysis of IQ modulated signals up to 3GHz. In the digital communications and positioning systems area a complete suite of new offices and laboratories has recently been established.

In the nanotechnology and photonics areas, we have new laboratories and clean rooms for terahertz electronics, photonics, molecular electronics and bio-electronics research. We have also developed a Molecular Beam Epitaxy facility to fabricate advanced compound semiconductor optoelectronic devices. The work is underpinned by a strong theory and modelling group in the quantum electronics area.

Strong industrial links

The course contents reflect the latest developments within research laboratories and current industrial applications. An Industrial Advisory Board ensures that industrial partners provide input into the ongoing development of the courses. At least one module is taught exclusively by staff from industry and we host talks and seminars by invited guest speakers.

Our research in the area of microwaves within our Institute of Microwaves and Photonics is strongly supported by Filtronic Plc and Agilent Technologies Inc. In addition, Yorkshire Forward has recognised our strengths in the wireless communications area by establishing the Centre of Industrial Collaboration (CIC) in Wireless Technology within our Institute of Integrated Information Systems.

Finally, staff within the School work closely with the IET (Institution of Engineering and Technology) and the IEEE (Institute of Electrical and Electronics Engineers), ensuring professional relevance of courses. Staff are also extensively involved in editing IEEE and IET journals and in the organisation of local, national and international events, including chairing major international conferences.

A recent panel visit by the Institution of Engineering and Technology (IET) commended the School's outstanding research expertise and recommended that the MSc courses are accredited for a full five years.

Careers

Alongside the specific content of our courses, you will be able to enhance your transferable professional skills, which are vital for future career development. The courses incorporate training in presentation skills, scientific writing, project management, intellectual property awareness, team working and applying research methodology.

Engineering Careers Fair

We hold an annual Engineering and Computing Careers Fair attracting over 32 graduate recruiters including organisations such as Atkins, AECOM, Balfour Beatty, BP, Deloitte, Ernst & Young, Jaguar Land Rover, Procter and Gamble, Network Rail and Thales, to name but a few. The fair provides you with the chance to explore the opportunities available after graduation.

Careers Centre

Our on-campus Careers Centre is one of the largest in the country. It offers an excellent range of services and has a great relationship with graduate recruiters. The Careers Centre can help you to improve your CV and complete job applications. The Careers Centre also holds training events and workshops to assist you with your career progression.

More information on the Careers Centre can be found at **www.careerweb.leeds.ac.uk**

Learning and assessment

All of our MSc courses operate on a credit-based modular system, with the year divided into three equal semesters. A standard module is worth 15 credits, whilst the project accounts for 60 credits. For the MSc course you are required to take the project and 8 modules totalling 180 credits. The taught modules and preparatory work for the research project is undertaken over the first two semesters with the summer being devoted to the research project.

A typical module involves two lectures per week, usually supported by tutorial/ practical classes. Most modules are assessed by examination, often with an element of course work. The project is assessed by dissertation and oral examination. We regularly award prizes, sponsored by industry, to reward students with top marks.

Research project

The project is possibly one of the most satisfying parts of the course. It gives you the opportunity to take what you have learnt and to explore and develop specific interests by applying it to your own piece of research.

The project is chosen by you and is usually associated with one of our world-class research institutes. You will work individually on a project and you will be assigned a project supervisor.

Recent research projects have included:

- Energy efficiency in anycast optical networks
- Modulation of Gunn devices and tunnel diodes with microwave signals
- Design and simulation of silicon based optoelectronic modulator
- Design and characterisation of vehicular ad hoc networks in a motorway scenario
- DC-AC inverter for grid side connection of an induction generator
- Microstrip phased array antenna
- Energy efficient geographic routing in ad-hoc wireless sensor networks
- Robot Jungle
- Node positioning and localisation in wireless sensor networks
- A hot electron solar cell based on titanium and copper
- Electronic energy conservation awareness display
- Multiple antenna transmission and OFDMA for WiMax
- Modelling and control of a DC motor simulating a wind turbine
- Radio telescope
- Optimised control of autonomous air vehicle for indoor navigation
- Lightweight cryptography for power constrained micro-controllers

The application process

Due to the high demand for our courses, we advise applying early. Applications from international students should be submitted by mid July and UK applications by early September of the year of entry. However, there is an application deadline of 30 June relating to the excellence scholarship and to be eligible for this, applicants need to have an offer of a place on one of our postgraduate courses.

For further information about applying for postgraduate study visit **www.leeds.ac.uk/pgthowtoapply**

Fees

For up-to-date details on fees please contact our Postgraduate Admissions Team or visit **www.engineering.leeds.ac.uk/masters-courses/fees**

Scholarships

We are part of the Faculty of Engineering, which offers a range of scholarships. Details can be found at **www.engineering.leeds.ac.uk/scholarships** or by contacting the Postgraduate Admissions Team. The University also offers a number of scholarships, for more information on these visit **http://scholarships.leeds.ac.uk**

English language requirements

Applicants whose first language is not English, or whose Bachelor's degree is not from a university in an English speaking country, are required to provide evidence of proficiency in English by having attained the following or its equivalent:

IELTS – 6.5 with not less than 6.0 in listening, reading, speaking and writing.

Pre-sessional English language courses are available at the Language Centre for students who wish to improve their language skills prior to commencing their studies, to find out more visit **www.leeds.ac.uk/languages/intro**

Contact us

If you have any queries please contact:

Postgraduate Admissions Team
School of Electronic and
Electrical Engineering
University of Leeds
Leeds LS2 9JT, UK

t: +44 (0)113 343 2035

e: electronic@leeds.ac.uk

w: **www.engineering.leeds.ac.uk/electronic**

Visit us

You are welcome to visit us, please contact the Postgraduate Admissions Team on

t: +44 (0)113 343 2035

Postgraduate masters courses:

MSc Broadband Wireless and Optical Communications

Broadband wireless access is the next communications revolution.

It is a vital element in enabling next generation quadruple play services (i.e. voice, video, data and mobility) and provides affordable and pervasive content access. As new video rich, bandwidth hungry services are developed, the challenge to deliver the next generation broadband networks is becoming more profound.

This course has been developed to respond to the communication trend of massive infrastructure investment into optical and high-speed broadband communications, especially WiMax. It deals with both the theoretical underpinnings, as well as the implementation and applications, of broadband communications technology.

One of the unique features of this MSc is the inclusion of a significant number of specialist industrial lectures, which allows you to relate the theoretical and design aspects of broadband technology with the practical limitations of real-world constraints. In addition the Digital Signal Processing laboratory (financially supported by Texas Instruments) will give you hands-on experience using the DSP technology that can be found in for example computers, cellular phones and MP3.

Finally, this MSc reflects the state of the art in the area of broadband communications and is delivered by research active staff who are internationally famous in their respective fields.

Who will benefit?

This course will appeal to:

- Graduates seeking to enhance their employability within the digital communications industry
- practising engineers wishing to learn about recent developments in WiMax and broadband communications.

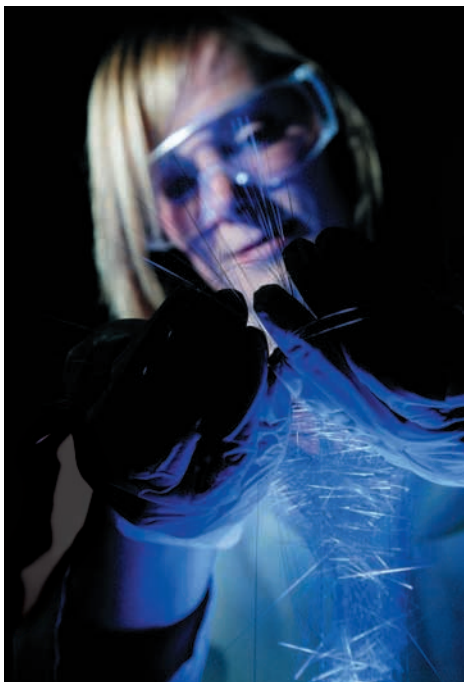
Typical careers

This course will provide you with an understanding of all aspects of broadband communications, from theory through implementation to applications. As a result, you can expect to have obtained the skills that will lead to employment in any area of the communications/signal processing industry including optical networking, DSP design and implementation, cellular mobile, RF planning, broadband systems and general communications research and development.

Entry requirements

A minimum UK upper second class (2:1) honours degree or equivalent in appropriate numerate disciplines usually electronic engineering, but others may be considered. In some special cases, if places are still available, applicants with a good lower second class (2:2) honours degree and who have relevant experience may also be considered and so should not be deterred from applying.

For English language requirements see page 07.



Course content

You will study the following modules and will also undertake a research project during the summer months.

Modules	Contents
Broadband Wireless Networks and WiMax	Introduces the basic principles of WiMax – one of the most important technologies (based upon OFDM) for mobile broadband communications, and the next big development in the modern communications revolution. Covers the basic principles of operation both from the physical (PHY) and medium access control (MAC) layers. The approach will be both analytic and descriptive. In addition, any possible limitations will be discussed as well as the economic and social aspects of its rollout.
Cellular Mobile Communications Systems	Focuses on the underlying principles of cellular mobile radio for voice, data and video, the limitations and possibilities of mobile communications, signal processing requirements, the need for protocols, the principles and practices of 2-G (e.g. GSM) and 3-G (e.g. WCDMA) systems. Specific topics include the cellular concept, radio wave propagation and digital transmission in cellular systems, the GSM system, basic principles of DS/CDMA, PN codes and Walsh sequences, correlator design, the Rake receiver and the WCDMA system.
Digital Signal Processing for Communications	Introduces the theoretical tools of digital signal processing (DSP) and shows the application of DSP in modern communication systems. The module will help you understand the realisation issues and trade-offs in practical designs. Topics covered will include time- and frequency-domain analysis for discrete-time systems; random processes and statistical signal processing; applications including speech coding, communications channel estimation, equalisation, adaptive signal processing and channel modelling.
DSP Hardware Implementation	Develops an understanding of the fundamental principles of how DSP algorithms are implemented in practice. Provides an insight into the operation (and limitations) of DSP chips. Gives hands-on experience of programming DSP chips. Also covers the basic principles to design and implement popular DSP algorithms taken from digital filtering, modulation, matched filtering, modems, adaptive filtering, etc.
Fundamentals of Communications Theory	Covers the fundamental principles underpinning communication systems. These include mathematical analysis of system behaviour, modelling the blocks in a communication system, the Shannon and Nyquist theories, models for estimating system bit error rate, elementary principles of decision/detection theory and their use in communication receivers.
Optical Communications Networks	Covers the essential elements of modern optical networks; the evaluation of WDM, optical time multiplexing and photonic packet switching. This module will also teach you to appreciate case studies and implementation scenarios and how to design virtual WDM networks; to understand the evolution of modern optical networks.
Photonics and Communications Technology	This module will help develop an understanding of the fundamental principles of optical fibre communication systems – including their advantages and limitations. In particular it will address the properties, advantages and disadvantages of the photonic components that are the enabling technology for future high-speed, broadband optical communications.
Wireless Communications Systems Design	This module addresses communication design at many different levels. At the system level it covers microwave systems, system modelling, sub-system characterisation and the delivery of complete communications systems in the real world. The propagation level covers system noise-figure analysis, link budgets and radio propagation analysis as a system planning tool. At the circuit level it includes; RF subsystems, direct and heterodyne conversion, RF integrated circuits, the impact of RF/microwave component design on wireless communication system performance, modulation formats and their impact on circuit design, and distortion and spectral re-growth.

This module list is an indicative list and actual content may vary as we regularly review the content of our courses in light of new experiences and developments in the field.

MSc Communications Engineering

Efficient and effective high-speed communications are essential for delivering healthcare, industrial development, transport, broadcasting and a whole other myriad of services that help every country prosper and develop economically and socially.

This MSc will deliver high calibre communications engineers equipped for such challenges of the 21st century.

This course is designed to meet the demand for engineers who understand modern communications techniques and the electronics that makes them work. At the physical level, it covers the propagation of radio waves and the behaviour of antennas. At the communications level, it ranges from the fundamentals of communication theory through modern modulation and coding techniques to cellular systems. At the electronics level, it complements these by dealing with the system-on-a-chip technology that implements much of modern systems. The course also benefits from a laboratory with a wide range of relevant and illustrative experiments.

Who will benefit?

This course will appeal to:

- Practising engineers who wish to keep up to date with new techniques of mobile telephony
- those wishing to gain a deeper understanding of both the RF and modulation/coding sides of modern communications.

Typical careers

Career prospects are excellent and graduates of this course should expect to develop careers in many branches of the communications industry including radio engineering and the mobile sector.

This is a sector characterised by increasingly specialised technologies, where up-to-date knowledge is essential and newly trained engineers are in demand. They are needed to support the continual upgrading of our communications infrastructure. This includes the migration from analogue to digital and normal to high-definition television, from second to third and third to fourth generation mobiles, and an ever-expanding range of systems such as Bluetooth, WiFi, WiMax and many others. Some of these migrations are under way, others are planned and will generate a continuing stream of employment prospects.

Entry requirements

A minimum UK upper second class (2:1) honours degree or equivalent in appropriate numerate disciplines usually electronic engineering, but others may be considered. In some special cases, if places are still available, applicants with a good lower second class (2:2) honours degree and who have relevant experience may also be considered and so should not be deterred from applying.

For English language requirements see page 07.

Course content

You will study the following modules plus two of the optional modules (you must choose one from each list of optional modules). You will also undertake a research project during the summer months.

Modules	Contents
Antennas and Radio Wave Propagation	Covers the factors governing the design and operation of modern wireless communication systems. These include fundamentals of antenna theory and propagation, radiation patterns of antennas (including both wire and aperture antennas), propagation mechanisms (including the effects of climate on them), link budgets and antenna arrays. Diversity, diffraction, fading, beamforming and topics specific to satellite and cellular systems are also covered.
Cellular Mobile Communications Systems	Focuses on the underlying principles of cellular mobile radio for voice, data and video, the limitations and possibilities of mobile communications, signal processing requirements, the need for protocols, the principles and practices of 2-G (e.g. GSM) and 3-G (e.g. WCDMA) systems. Specific topics include the cellular concept, radio wave propagation and digital transmission in cellular systems, the GSM system, basic principles of DS/CDMA, PN codes and Walsh sequences, correlator design, the Rake receiver and the WCDMA system.
Fundamentals of Communications Theory	Covers the fundamental principles underpinning communication systems. These include mathematical analysis of system behaviour, modelling the blocks in a communication system, the Shannon and Nyquist theories, models for estimating system bit error rate, elementary principles of decision/detection theory and their use in communication receivers.
Mini Projects Laboratory	Designed to provide experience of practical electronics and measurement techniques. Particularly suitable for students without an electronic engineering bachelor's degree. Laboratory work covers measurement and sampling techniques, RF and microwave network analysers, antenna measurements and embedded systems. You will choose two mini projects from a range including RF amplifier design and test, an infra-red data link, an embedded system and acoustic measurements in a well-equipped sound studio.
Modulation and Coding for Digital Communications	Covers modern digital modulation and demodulation (e.g. BPSK, QPSK, QAM, GMSK, OFDM), carrier and timing recovery, forward error correction and detection, including block coding, convolutional coding, Turbo codes and Monte-Carlo methods for performance evaluation.
Wireless Communications Systems Design	This module addresses communication design at many different levels. At the system level it covers microwave systems, system modelling, sub-system characterisation and the delivery of complete communications systems in the real world. The propagation level covers system noise-figure analysis, link budgets and radio propagation analysis as a system planning tool. At the circuit level it includes; RF subsystems, direct and heterodyne conversion, RF integrated circuits, the impact of RF/microwave component design on wireless communication system performance, modulation formats and their impact on circuit design, and distortion and spectral re-growth.
Optional Modules (1)	You will choose one module from the following:
Data Communications and Sensor Networks	Provides a knowledge and understanding of data communications and wireless sensor networks and how they are, and could be, used in a range of applications.
DSP Hardware Implementation	Develops an understanding of the fundamental principles of how DSP algorithms are implemented in practice. Provides an insight Into the operation (and limitations) of DSP chips. Gives hands-on experience of programming DSP chips. Also covers the basic principles to design and implement popular DSP algorithms taken from digital filtering, modulation, matched filtering, modems, adaptive filtering, etc.
Photonics and Communications Technologies	This module will help develop an understanding of the fundamental principles of optical fibre communication systems – including their advantages and limitations. In particular it will address the properties, advantages and disadvantages of the photonic components that are the enabling technology for future high-speed, broadband optical communications.
Optional Modules (2)	You will choose one module from the following:
DSP Hardware Implementation	Develops an understanding of the fundamental principles of how DSP algorithms are implemented in practice. Provides an insight Into the operation (and limitations) of DSP chips. Gives hands-on experience of programming DSP chips. Also covers the basic principles to design and implement popular DSP algorithms taken from digital filtering, modulation, matched filtering, modems, adaptive filtering, etc.
Embedded Systems Design	This module introduces students to contemporary hardware and software development tools for mobile and embedded devices.
Medical Electronics and E-Health	Provides a knowledge and understanding of how electronics and communications technology is, and could be, used in medical applications and healthcare.

This module list is an indicative list and actual content may vary as we regularly review the content of our courses in light of new experiences and developments in the field.

MSc Electronic and Electrical Engineering

Commercial products today combine many technologies, and industry is increasingly interdisciplinary. As a result there is a demand from employers for engineers with a broad knowledge but also with a deep understanding of several subjects.

This course meets this demand and has been developed to provide engineers with an interdisciplinary knowledge base in modern electronics, including power, communications, control and embedded processors.

This course is designed to give engineers a broad grasp of a range of inter-locking disciplines. It will appeal to people with a wide range of interests in electronics and communications, people who are generalists as well as specialists. It will suit those who are interested in modern communications techniques, radio propagation, cellular mobile systems, control systems, power and drives, and modern system-on-a-chip technology. This course also has an associated laboratory module with a wide range of relevant and illustrative experiments.

Who will benefit?

This course will appeal to:

- Graduates wishing to convert to develop a career in electronic and electrical engineering
- practising engineers who wish to develop a depth of knowledge across a broad cross-disciplinary range of electronics.

Typical careers

Graduates of this course can expect to find jobs where industry needs a breadth of knowledge matched by a depth in certain areas. Such people will be well equipped to integrate and co-ordinate the stands of a cross-disciplinary project and manage the interfaces between specialities.

Such engineers would expect to progress to project management in companies working at the cutting edge of modern multi-faceted systems.

Entry requirements

A minimum UK upper second class (2:1) honours degree or equivalent in appropriate numerate disciplines usually electronic engineering, but others may be considered. In some special cases, if places are still available, applicants with a good lower second class (2:2) honours degree and who have relevant experience may also be considered and so should not be deterred from applying.

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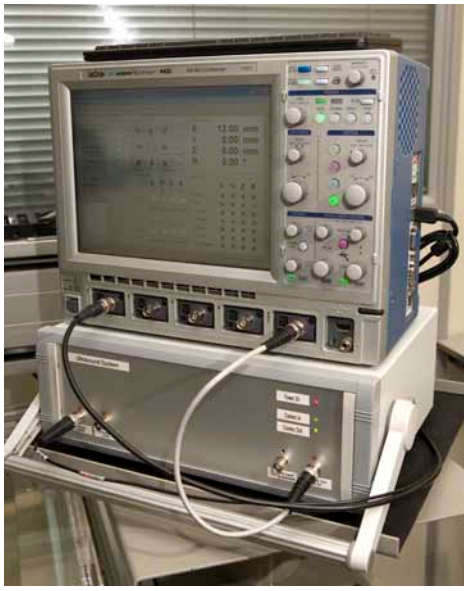


Course content

You will study the following modules plus six of the optional modules (you must choose two from the first list and four from the second list of optional modules). You will also undertake a research project during the summer months.

Modules	Contents
Electronics Industry Dissertation	This module develops a detailed understanding of the global electronics industry. The topic of the dissertation is to be agreed with the Module Leader, with examples being an essay on a particular aspect of the electronics industry, a proposal for research funding, a business plan, or a manufacturing/outsourcing plan.
Mini Projects and Laboratory	Covers a range of circuits, systems and laboratory equipment.
Optional Modules (1)	You will choose two modules from the following:
Control Systems Design	This module covers the analysis and design of control systems. Knowledge and understanding of linear systems is developed to enable analysis of control systems using analytical techniques and computer tools.
Data Communications and Sensor Networks	Provides a knowledge and understanding of data communications and wireless sensor networks and how they are, and could be, used in a range of applications.
Digital Media Engineering	This module provides in-depth coverage of issues relating to the recording, transmission, storage and replaying of multimedia content. The syllabus includes: DRM formats and their impact for revenue generation within the field of content distribution, property rights and licensing protection, differentiate supply chain services for pushing digital content within video, music and gaming industries, quantify storage requirements, scaling strategies and control methodologies for digital production management. You will learn how modern system-on-chip technology is employed for the processing of digital signals and how content is broadcast or distributed securely using broadband and wireless networks.
Electric Power Generation by Renewable Sources	This module provides you with a knowledge and understanding of power generation technology from renewable sources, particularly wind and solar power. It describes how renewable energy sources can be employed and how they are integrated into electricity systems. It covers the control and management of photovoltaic and wind power generation systems comprising power converters and energy storage components. You will learn about the control of micro-grid, including active and reactive power control and harmonic elimination. The module is supported by practical examples and case studies.
Wireless Communications Systems Design	This module addresses communication design at many different levels. At the system level it covers microwave systems, system modelling, sub-system characterisation and the delivery of complete communications systems in the real world. The propagation level covers system noise-figure analysis, link budgets and radio propagation analysis as a system planning tool. At the circuit level it includes; RF subsystems, direct and heterodyne conversion, RF integrated circuits, the impact of RF/microwave component design on wireless communication system performance, modulation formats and their impact on circuit design, and distortion and spectral re-growth.
Optional Modules (2)	You will choose four modules from the following:
Antennas and Radio Wave Propagation	Covers the factors governing the design and operation of modern wireless communication systems. These include fundamentals of antenna theory and propagation, radiation patterns of antennas (including both wire and aperture antennas), propagation mechanisms (including the effects of climate on them), link budgets and antenna arrays. Diversity, diffraction, fading, beamforming and topics specific to satellite and cellular systems are also covered.
Digital Design for System-on-Chip	Introduces the basic design principles of digital signal processing systems using VLSI technologies. With silicon feature size below 100nm and densities reaching 1 billion transistors per chip, many complex systems can now be implemented on a single chip. Using Altera Quartus, ModelSim and Mentor Graphics EDA design tools, students learn the academic foundations of complex system design through practical assignments.
DSP Hardware Implementation	Develops an understanding of the fundamental principles of how DSP algorithms are implemented in practice. Provides an insight Into the operation (and limitations) of DSP chips. Gives hands-on experience of programming DSP chips. Also covers the basic principles to design and implement popular DSP algorithms taken from digital filtering, modulation, matched filtering, modems, adaptive filtering, etc.
Embedded Systems Design	This module introduces students to contemporary hardware and software development tools for mobile and embedded devices.
Medical Electronics and E-Health	Provides a knowledge and understanding of how electronics and communications technology is, and could be, used in medical applications and healthcare.
Power Electronics and Drives	Covers FET, IGBT and MOSFET switches: characteristics, limitations, fields of use, switching loss and thermal behaviour. Switched-mode power supplies with transformer insulation, forward and flyback converters. Dynamics of induction motor drives, adjustable frequency induction motor drives, brushless d.c. motor, stepping motor and switched-reluctance motor drive systems are also covered.

This module list is an indicative list and actual content may vary as we regularly review the content of our courses in light of new experiences and developments in the field.

MSc Electrical Engineering and Renewable Energy Systems

Renewable energy and reduction of carbon emissions are top of the global agenda. This course addresses the fundamentals of renewable energy and how solar, wind, wave and other such energy sources can be efficiently integrated into practical power systems.

This is an advanced course in the area of electrical engineering applied to renewable energy systems. It is distinctive in that it provides a strong core of power electronic converters, machines and control backed up with modules on power generation and electronic conversion with renewable energy sources.

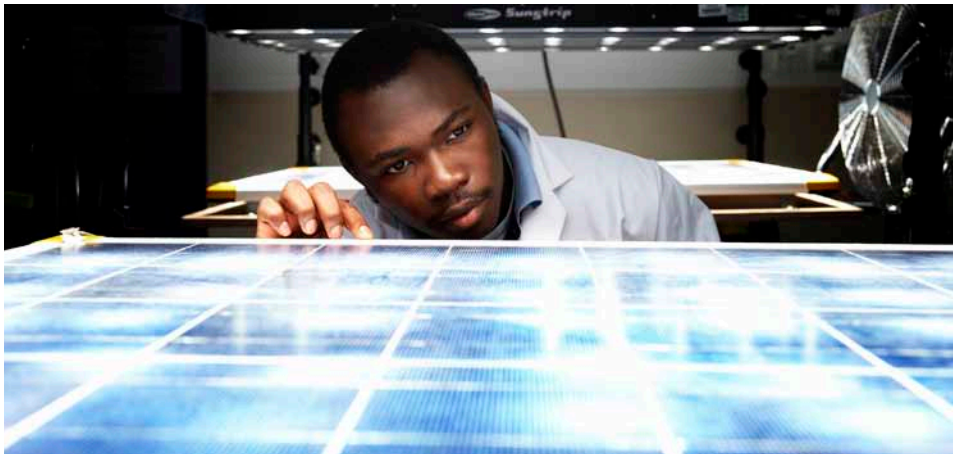
The course offers a unique set of modules in the efficient generation and use of electricity from solar, wind and wave power. The integration of renewable generators into micro grids, with stability analysis and active power management, is also covered. The design of power electronics is treated in depth, including conventional and emerging converter topologies and semiconductor power devices.

You will undertake substantial elements of practical work giving you confidence with hardware implementations using electric drives, microcontroller control and electronic conversion circuits. Project work is highly rewarding and conducted in a research-led environment, with selected students having the opportunity to carry out an industrial placement for their project.

Who will benefit?

This course will appeal to:

- Graduates wishing to develop a career in electrical engineering applied to renewable energy systems
- practising engineers who wish to study the latest techniques in the engineering of renewable energy systems and efficient power converters, machines and control systems.



Typical careers

Renewable energy and efficient power conversion systems are of immense importance worldwide and graduates of this course can expect to find jobs in a wide variety of industries including the electronics, automotive, transport, construction, industrial automation, energy, oil and environmental sectors.

Graduates of this course will be well placed to develop practical solutions to the problem of integrating renewable energy systems into established electricity distribution networks. They should be able to contribute to strategic planning, systems implementation and operation of sustainable power generation systems.

Entry requirements

A minimum UK upper second class (2:1) honours degree or equivalent in appropriate numerate disciplines usually electronic engineering, but others may be considered. In some special cases, if places are still available, applicants with a good lower second class (2:2) honours degree and who have relevant experience may also be considered and so should not be deterred from applying.

For English language requirements see page 07.

Course content

You will study the following modules plus three of the optional modules. You will also undertake a research project during the summer months.

Modules	Contents
Control Systems Design	This module covers the analysis and design of control systems. Knowledge and understanding of linear systems is developed to enable analysis of control systems using analytical techniques and computer tools.
Electric Drives	Describes electrical machines and the fundamental principles of their control to enable you to engineer complete drive systems for control of torque and speed. Classical machines that are covered include the three-phase induction machine in generating and braking modes, with variable frequency and variable-voltage methods for speed control.
Electric Power Generation by Renewable Sources	This module provides you with a knowledge and understanding of power generation technology from renewable sources, particularly wind and solar power. It describes how renewable energy sources can be employed and how they are integrated into electricity systems. It covers the control and management of photovoltaic and wind power generation systems comprising power converters and energy storage components. You will learn about the control of micro-grid, including active and reactive power control and harmonic elimination. The module is supported by practical examples and case studies.
Grid-Connected Microgeneration Systems	An introduction to how small renewable sourced powered generators can be integrated into the grid. Issues relating to the interconnection of renewable sources and control and protection methods will be explored.
Micro-grid Laboratory	This module offers an opportunity to consolidate your understanding of grid-connected renewable energy generation systems, and to develop your skills in modelling, designing and controlling such systems. Topics covered will complement the materials studied in Electric Power Generation by Renewable Sources and Grid-Connected Microgeneration.
Mini Projects Laboratory	Designed to provide experience of practical electronics and measurement techniques. Particularly suitable for students without an electronic engineering bachelor's degree. Laboratory work covers measurement and sampling techniques, RF and microwave network analysers, antenna measurements and embedded systems. You will choose two mini projects from a range including RF amplifier design and test, an infra-red data link, an embedded system and acoustic measurements in a well-equipped sound studio.
Optional Modules	
Advanced Energy Systems	This module describes the full range of electricity generation techniques including the principles of coal, oil and nuclear power stations. It covers fluidised bed combustion and combined cycles for power generation. Aspects of nuclear power that are taught include fission reactor theory, neutron diffusion and moderation, reactor heat transfer, reactor dynamics and reactor safety. An introduction to tidal and wave power systems is given, including prospects for increased use of renewable sources.
Climate Change: Impacts and Adaptation	Gives an overview of climate change impact assessment and predictions, and key concerns and strategies of adaptation to climate change.
Climate Change Mitigation	Outlines the relative significance of main sources of greenhouse gases and the potential, technologies and strategies for reducing them.
Climate Change: Physical Science Basis	Introduces the students to the physical science base on climate change. Includes sessions on the global climate system, carbon cycle, radiative forcing, past climates, climate modelling, climate predictions, and the handling of uncertainty in climate change research.
Embedded Systems Design	This module introduces students to contemporary hardware and software development tools for mobile and embedded devices.
Power Electronics and Drives	Covers FET, IGBT and MOSFET switches: characteristics, limitations, fields of use, switching loss and thermal behaviour. Switched-mode power supplies with transformer insulation, forward and flyback converters. Dynamics of induction motor drives, adjustable frequency induction motor drives, brushless d.c. motor, stepping motor and switched-reluctance motor drive systems are also covered.
Sustainable Energy Processes	This module begins with the basics of renewable energy processes and progresses to detailed theory and current developments of the main resources. You will develop a sound knowledge of the underlying principles of the main renewable energy technologies and in the production of biofuels and sustainable hydrogen and you will learn about the drivers of sustainable energy and the environmental issues associated with this.

This module list is an indicative list and actual content may vary as we regularly review the content of our courses in light of new experiences and developments in the field.

MSc Embedded Systems Engineering

The huge growth of processing power, now available in small power efficient packages has fuelled the digital revolution. All sectors of the economy have been touched by the digital revolution.

From the consumer electronics industry we have seen MP3 players, PDA devices, HDTV and games consoles. The car industry has seen tremendous developments in adaptive control, engine management and GPS. Advances in Personal Communications have given rise to WiFi and GSM networks. Medical and Process Industries now have sensing and imaging technologies that can visualise three dimensionally in real-time. Banking and commerce require secure online transactions which are only possible through encryption algorithms encoded within embedded systems.

The growth of tools and techniques within this sector has led to a significant skills shortage, particularly for those trained at the highest level.

This is a practically-orientated and advanced course in the area of electronics design and applications. It is distinctive in that it provides a strong digital technology core backed up with applications-led modules. Examples of these applications include medical and electronics, e-health, intelligent building design, automotive electronics, retail and commerce.

This broad coverage of diverse applications cannot be found in any comparable courses in the UK. This is beneficial to you as it prepares you for a range of careers in industry.

Another feature of the course is the substantial amounts of practical work, giving you the confidence with software and digital hardware implementations using microcontrollers, FPGA, DSP devices and general system-on-chip the methodology.

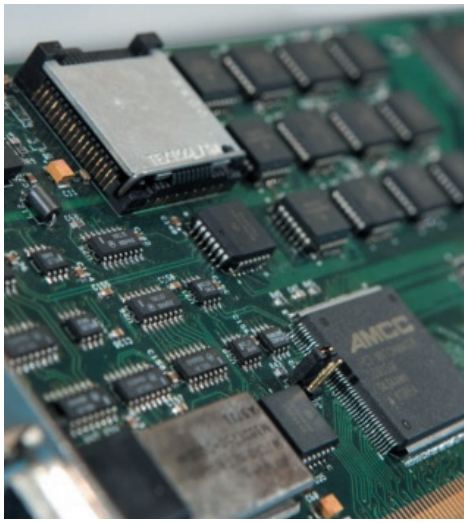
Who will benefit?

This course will appeal to:

- Graduates who have been working in the electronics industry but who wish to re-skill and further their career
- recent graduates wishing to become specialised in embedded systems
- graduates who would like to update their qualifications
- lecturers and teachers in the field of embedded systems engineering.

Typical careers

Embedded systems are ubiquitous in engineering and graduates are likely to find employment in a wide and diverse range of industries including: communications, automotive, transport, construction, industrial, automation, energy and environmental monitoring. Recent graduates have found employment with IBM, BAE Systems, Pace Micro Technology, ARM Inc, and Motorola.



Entry requirements

A minimum UK upper second class (2:1) honours degree or equivalent in appropriate numerate disciplines usually electronic engineering, but others may be considered. In some special cases, if places are still available, applicants with a good lower second class (2:2) honours degree and who have relevant experience may also be considered and so should not be deterred from applying.

For English language requirements see page 07.

Course content

You will study the following modules and will also undertake a research project during the summer months.

Modules	Contents
Data Communications and Sensor Networks	Provides a knowledge and understanding of data communications and wireless sensor networks and how they are, and could be, used in a range of applications.
Digital Design for System-on-Chip	Introduces the basic design principles of digital signal processing systems using VLSI technologies. With silicon feature size below 100nm and densities reaching 1 billion transistors per chip, many complex systems can now be implemented on a single chip. Using Altera Quartus, ModelSim and Mentor Graphics EDA design tools, students learn the academic foundations of complex system design through practical assignments.
Digital Media Engineering	This module provides in-depth coverage of issues relating to the recording, transmission, storage and replaying of multimedia content. The syllabus includes: DRM formats and their impact for revenue generation within the field of content distribution, property rights and licensing protection, differentiate supply chain services for pushing digital content within video, music and gaming industries, quantify storage requirements, scaling strategies and control methodologies for digital production management. You will learn how modern system-on-chip technology is employed for the processing of digital signals and how content is broadcast or distributed securely using broadband and wireless networks.
Digital Signal Processing for Communications	Introduces the theoretical tools of digital signal processing (DSP) and shows the application of DSP in modern communication systems. The module will help understand the realisation issues and trade-offs in practical designs. Topics covered will include time- and frequency-domain analysis for discrete-time systems; random processes and statistical signal processing; applications including speech coding, communications channel estimation, equalisation, adaptive signal processing and channel modelling.
DSP Hardware Implementation	Develops an understanding of the fundamental principles of how DSP algorithms are implemented in practice. Provides an insight into the operation (and limitations) of DSP chips. Gives hands-on experience of programming DSP chips. Also covers the basic principles to design and implement popular DSP algorithms taken from digital filtering, modulation, matched filtering, modems, adaptive filtering, etc.
Embedded Systems Design	This module introduces students to contemporary hardware and software development tools for mobile and embedded devices.
Medical Electronics and E-Health	Provides a knowledge and understanding of how electronics and communications technology is, and could be, used in medical applications and healthcare.
Mini Projects Laboratory	Designed to provide experience of practical electronics and measurement techniques. Particularly suitable for students without an electronic engineering bachelor's degree. Laboratory work covers measurement and sampling techniques, RF and microwave network analysers, antenna measurements and embedded systems. You will choose two mini projects from a range including RF amplifier design and test, an infra-red data link, an embedded system and acoustic measurements in a well-equipped sound studio.

This module list is an indicative list and actual content may vary as we regularly review the content of our courses in light of new experiences and developments in the field.

MSc Nanotechnology and Advanced Electronic Devices

This course will advance your knowledge to the cutting edge of nanotechnology, nanoelectronics, high-speed (terahertz) and quantum optoelectronic device research.

It is particularly suited to you if you have an electronic engineering or physical science background and want to pursue a career in research.

The course is derived directly from the research of the School's highly successfully world-class research Institute of Microwaves and Photonics (IMP). In recent years the research of the IMP has developed to include high frequency (terahertz) sources and systems, quantum optoelectronics (including infrared and terahertz lasers and photodetectors), molecular and bio-nanoelectronics.

The internationally recognised research leaders in IMP developed this course to develop tomorrow's scientists and engineers who will drive forward future innovation in the electronics and communications industries.

Who will benefit?

This course will appeal to:

- Graduates wishing to develop a career in the applications of nanotechnology to electronics
- electronic engineering graduates seeking to learn about the future of the subject
- practising engineers who wish to keep up to date with new technologies
- those wishing to gain deeper knowledge and understanding of modern communications and nanotechnology.

Typical careers

This course will allow you to pursue a career in research either in a university environment through a PhD or through the research and development arm of a high-tech. electronics, communications or computing company.

Entry requirements

A minimum UK upper second class (2:1) honours degree or equivalent in appropriate numerate disciplines usually electronic engineering, but others may be considered. In some special cases, if places are still available, applicants with a good lower second class (2:2) honours degree and who have relevant experience may also be considered and so should not be deterred from applying.

For English language requirements see page 07.

Course content

You will study the following modules and will also undertake a research project during the summer months.

Modules	Contents
Medical Electronics and E-Health	Provides a knowledge and understanding of how electronics and communications technology is, and could be, used in medical applications and healthcare.
Micro- and Nano-Electromechanical Systems	Covers how micro- and nano-electromechanical systems operate, the fabrication process and choice of materials, different approaches to implementation and how to quantify the performance of simple structures. This module provides a working knowledge of the principles of operation, physical structure, fabrication methods and properties of a range of such systems.
Molecular-Scale Engineering	Covers the basic technologies for molecular-scale engineering and molecular self-assembly, in particular the use of DNA as a means of directing the self-assembly of molecular-scale components into circuits and onto conventional semiconductor structures.
Nanofabrication and Characterisation	Provides a knowledge and understanding of advanced nanofabrication techniques and develops competence with a range of clean room processing and characterisation techniques.
Next Generation Silicon Technologies	Familiarises students with the most important aspects of silicon chip fabrication technology and the future technical challenges to be faced to ensure future progress and the proposed solutions. The Semiconductor Industry Association Technology Roadmap features in this module.
Photonics and Communications Technologies	This module will help develop an understanding of the fundamental principles of optical fibre communication systems – including their advantages and limitations. In particular it will address the properties, advantages and disadvantages of the photonic components that are the enabling technology for future high-speed, broadband optical communications.
Quantum Electronics and Spintronics	This module provides students with extensive knowledge of the design and operation of quantum and spintronic devices.
Terahertz Technology	Devices and technologies for the realisation of Terahertz systems. You will learn the principles of the main applications of Terahertz frequencies, which will allow you to determine the usefulness of Terahertz signals for a variety of applications and how to choose suitable devices and components to construct a Terahertz system.

This module list is an indicative list and actual content may vary as we regularly review the content of our courses in light of new experiences and developments in the field.

Research degrees

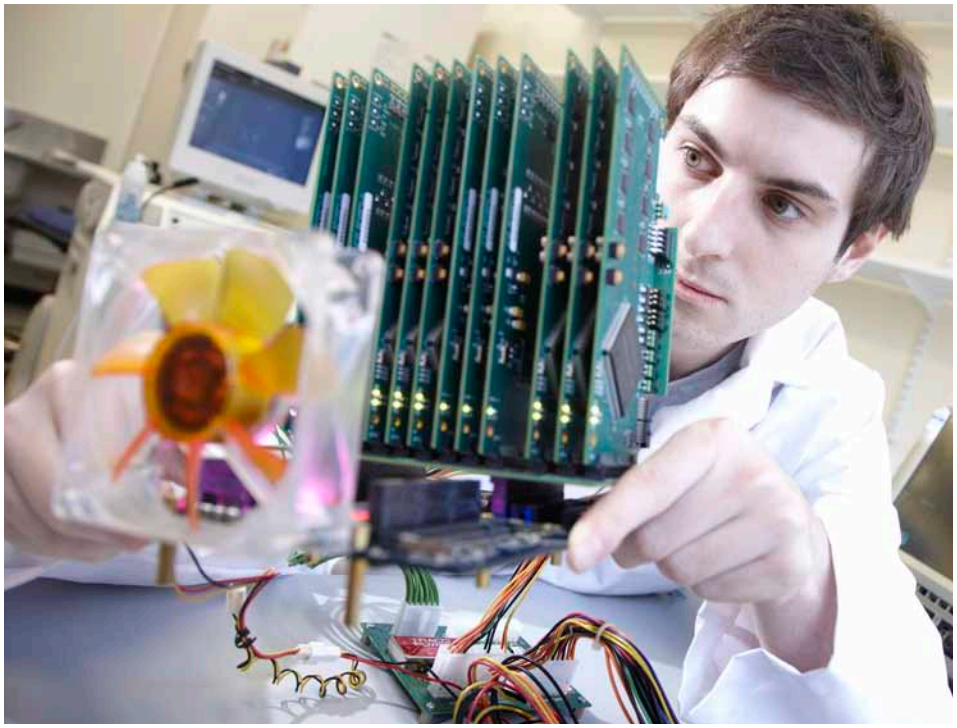
Our international reputation for research makes our School an ideal place to pursue a research degree, whether as preparation for a research career in industry or as the start of an academic career.

All research students carry out a programme of research in a particular area under the supervision of a primary supervisor and one or more co-supervisors. Supervisors are usually staff within the School; however co-supervisors may be from another discipline, another institution or even industry depending on the project and funding source.

You are assessed towards the end of your first year (second year for part-time students) through a report and oral examination; successful completion enables progression into the remaining years. At the end of the programme you will prepare a thesis which describes your research and your original contribution to knowledge which is assessed by oral examination.

Once registered, specific training needs will be identified and suitable courses recommended. During the later stages of your study you will be expected to give seminars and write papers for scientific journals and conferences.

Research activity within the School of Electronic and Electrical Engineering is organised into 2 research institutes; the Institute of Integrated Information Systems, and the Institute of Microwaves and Photonics.



Institute of Integrated Information Systems (I3S)

The Institute of Integrated Information Systems has an established international reputation for excellence across a broad range of modern electronic engineering research. Our current activities include signal processing for communications, communications theory, sensor networks, ultrasonics, optical communication, and communication networks. We have recently invested in a new area of research into quantum communications, which is expanding our activities still further.

A new wireless communications laboratory has recently been constructed and £1.3 million of strategic research infrastructure funding has enabled a complete refurbishment of all the Institute laboratories.

We have significant research funding from a number of sponsors including the UK research council (EPSRC), and our expansion into optical communications and networking has strengthened our industrial links, which now include all major telecommunications companies.

Research areas

- Signal Processing for Communications
- Sensors and Instrumentation
- Communication Networks and Systems

For further information on the Institute of Integrated Information Systems visit **www.engineering.leeds.ac.uk/i3s**

Institute of Microwaves and Photonics (IMP)

The research activities of the Institute of Microwaves and Photonics are much wider than might be first assumed from the Institute's name. The Institute has two broad research themes. The first theme is concerned with the generation, detection and exploitation of radiation from the millimetre/microwave region of the electromagnetic spectrum, through the terahertz frequency range, and to the mid-infrared and beyond.

The second theme is concerned with the design, fabrication and measurement of electronic and photonic nanostructured devices, and even involves the exploitation of biological processes for directed assembly of nanostructures and the development of molecular-scale electronic devices.

We have exceptionally well-equipped laboratories for the fabrication and measurement of microwave, millimetre- and sub-millimetre-wave devices, an extensive terahertz frequency photonics laboratory, a two-storey class-100 cleanroom, a III-V semiconductor molecular beam epitaxy facility, and a suite of laboratories for molecular nanotechnology and bioelectronics.

You will also have access to a new, world-leading, £4.5 million electron-beam lithography facility capable of sub-10-nm patterning. In addition, we have excellent computing facilities, including a super-computer cluster and state-of-the-art CAD packages.

Research is funded by a variety of sources including the UK research councils (EPSRC, BBSRC), the European Community, government agencies such as the Ministry of Defence, and industry.

Research areas

- Terahertz Electronics and Photonics
- Semiconductor Nanotechnology
- Microwave and Millimetre-wave Engineering
- Quantum Electronics
- Bio-Nanoelectronics

For further information on the Institute of Microwaves and Photonics visit **www.engineering.leeds.ac.uk/imp**

How to apply

For information regarding the application process visit:
www.engineering.leeds.ac.uk/electronic/postgraduate/research-degrees

Centre for Doctoral Training in Molecular-Scale Engineering

We also lead an EPSRC funded Centre for Doctoral Training (CDT) in Molecular-Scale Engineering, which brings together internationally-leading researchers at the Universities of Leeds and Sheffield to train high calibre science and engineering graduates in the control of molecular organisation and function at the nanometre scale.

Our Centre is dedicated to training doctoral scientists in new technologies for molecular-scale engineering. It provides a carefully structured programme of taught, cross-disciplinary training, with hands-on access to state-of-the-art instrumentation, and the opportunity to pursue doctoral training with world-class academics working at the forefront of molecular-scale engineering. A bespoke programme of cohort-building activities together with transferable skills and personal development has also been designed to complement the scientific and engineering training.

Our Centre is funded by the Engineering and Physical Sciences Research Council (EPSRC), a UK government agency, which invests more than £850 million a year in research and training in engineering and the physical sciences. Each year we offer a number of integrated 4 year funded PhD studentships.

For further information visit:
www.engineering.leeds.ac.uk/molecular-scale

About the University

The University of Leeds is one of the UK's top universities. Our degrees are well respected by employers and universities worldwide; in the 2010 QS World University Rankings, our Employer Review score was 88%.

Established in 1904, we are part of the prestigious Russell Group – the 20 leading research universities in the UK. We are also in the top ten UK research intensive universities. We have performed consistently well in the National Student Survey, in fact, in the latest survey, 82% of students said they were very satisfied or satisfied with their experience at Leeds.

Our single-site campus is conveniently located, a short 10 minute walk to the city centre providing access to a vibrant city life and excellent local services and facilities.

We have more than 5,000 taught postgraduate students and 2,000 research postgraduate students. Students come from over 130 countries to make use of our outstanding facilities, including a major academic research library, laboratories and computing facilities.

Located at the heart of our campus, is our award-winning Students' Union which has over 31,000 members. It is an excellent University resource that hosts postgraduate networking events and provides specialist advice on a range of issues including academic support, housing, money and finances.

Our new £12 million gym and pool, The Edge is one of the biggest on any university campus. Featuring a 200-station fitness suite, squash courts, climbing wall, Starbucks café, steam room and sauna, plus much more, it has something for everyone. For more information visit **www.leeds.ac.uk/sports**

The diverse community of cultures studying and working within the University enriches the experience of studying at Leeds. We are committed to providing an excellent level of service and support for all our students and for international students we have extensive academic support services including a Language Centre and a Skills Centre.

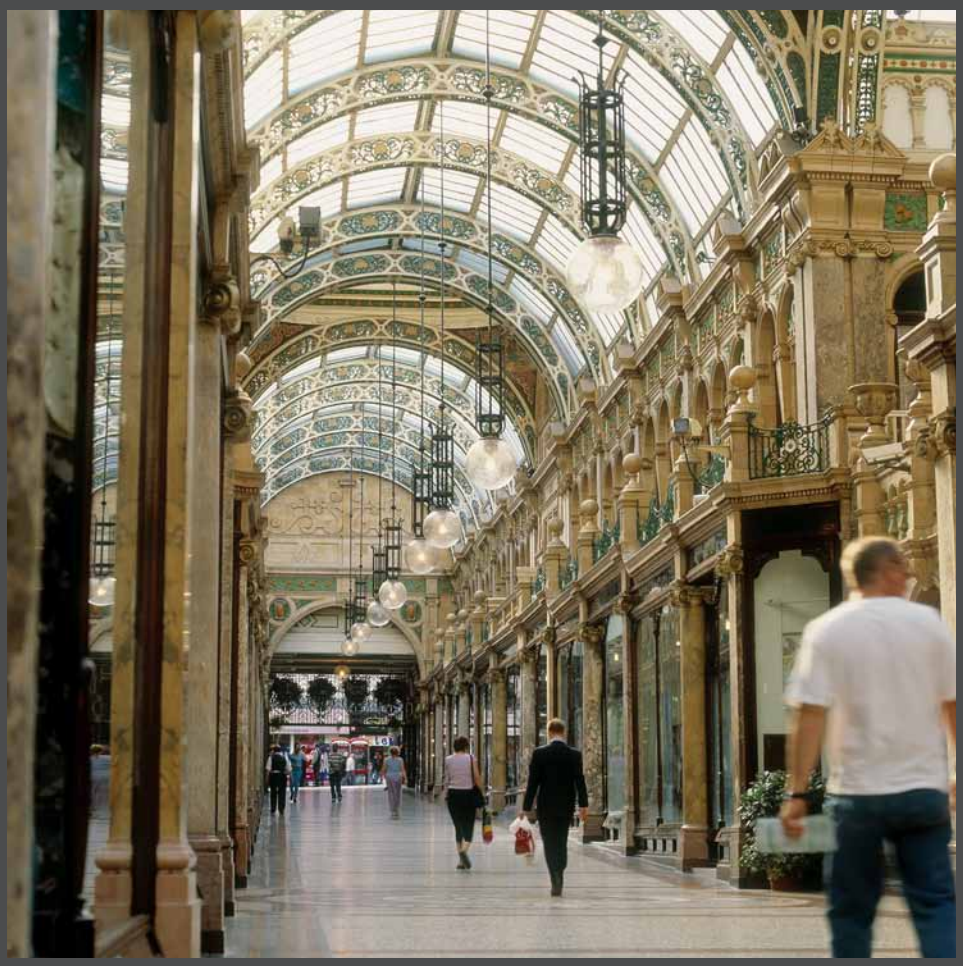
The University of Leeds is one of the most popular destinations in the UK for high-quality international students. An active International Centre brings together the international student community and is a source of information, guidance and support, as well as a great place to make new friends. International students have a guaranteed place in University accommodation throughout their studies, provided that a completed application form and deposit reaches us before the summer deadlines.* For more information visit **www.leeds.ac.uk/international**

***This guarantee applies to all single students from outside the EU.**

About the city

Leeds is a fantastic place to live and learn; it's a multi-cultural and cosmopolitan city with over 200,000 students, all enjoying the safe, friendly environment.

Leeds is renowned as a major shopping destination and centre for entertainment, nightlife, the arts and leisure. The city boasts over two miles of traffic-free shopping and beautiful Victorian and Edwardian arcades filled with shops of every kind. The city also offers an extensive choice of places to eat and drink whatever your culinary tastes or budgets. Nightlife in and around the city is known for its diversity and popularity, and offers a range of music to suit all tastes.



Leeds is one of the greenest cities in Britain with more parkland than any other European city. In and around Leeds you will find many areas of natural beauty and within easy reach of the city are the national parks of the Yorkshire Dales, Peak District, Lake District and historic towns such as York, Harrogate and Bradford.

Located at the heart of the UK, Leeds is midway between Edinburgh and London making it an ideal centre from which to visit other parts of the country. Leeds can be reached easily by train from any part of the UK, and is served by Leeds/Bradford International Airport, with train connections from Manchester and London International Airports.

Adapting to life in a new place can be both exciting and challenging. Finding somewhere to live where you feel comfortable will help you settle in quickly. Leeds has plenty of accommodation to choose from: residences large and small, in contemporary or traditional buildings, on campus or off campus. All of our accommodation is within easy walking distance to campus or on a frequent bus route. Living in University accommodation is one of the best ways to make new friends and help you settle into university life. For more information visit **www.leeds.ac.uk/accommodation**

UNIVERSITY OF LEEDS

Postgraduate Admissions Team
School of Electronic and Electrical Engineering
University of Leeds
Leeds LS2 9JT, UK

t **+44 (0)113 343 2035** f **+44 (0)113 343 2032**
e **electronics@leeds.ac.uk**
w **www.engineering.leeds.ac.uk/electronic**