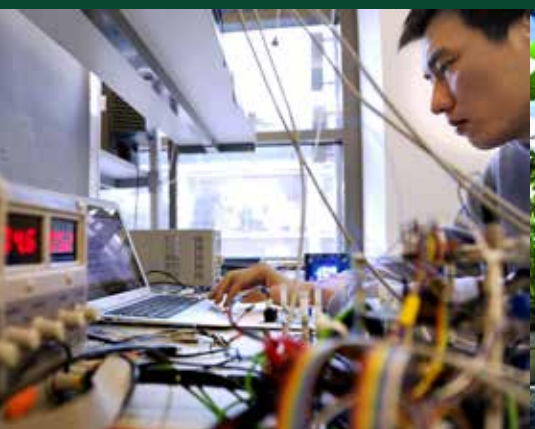
THE UNIVERSITY *of* EDINBURGH
School of Engineering

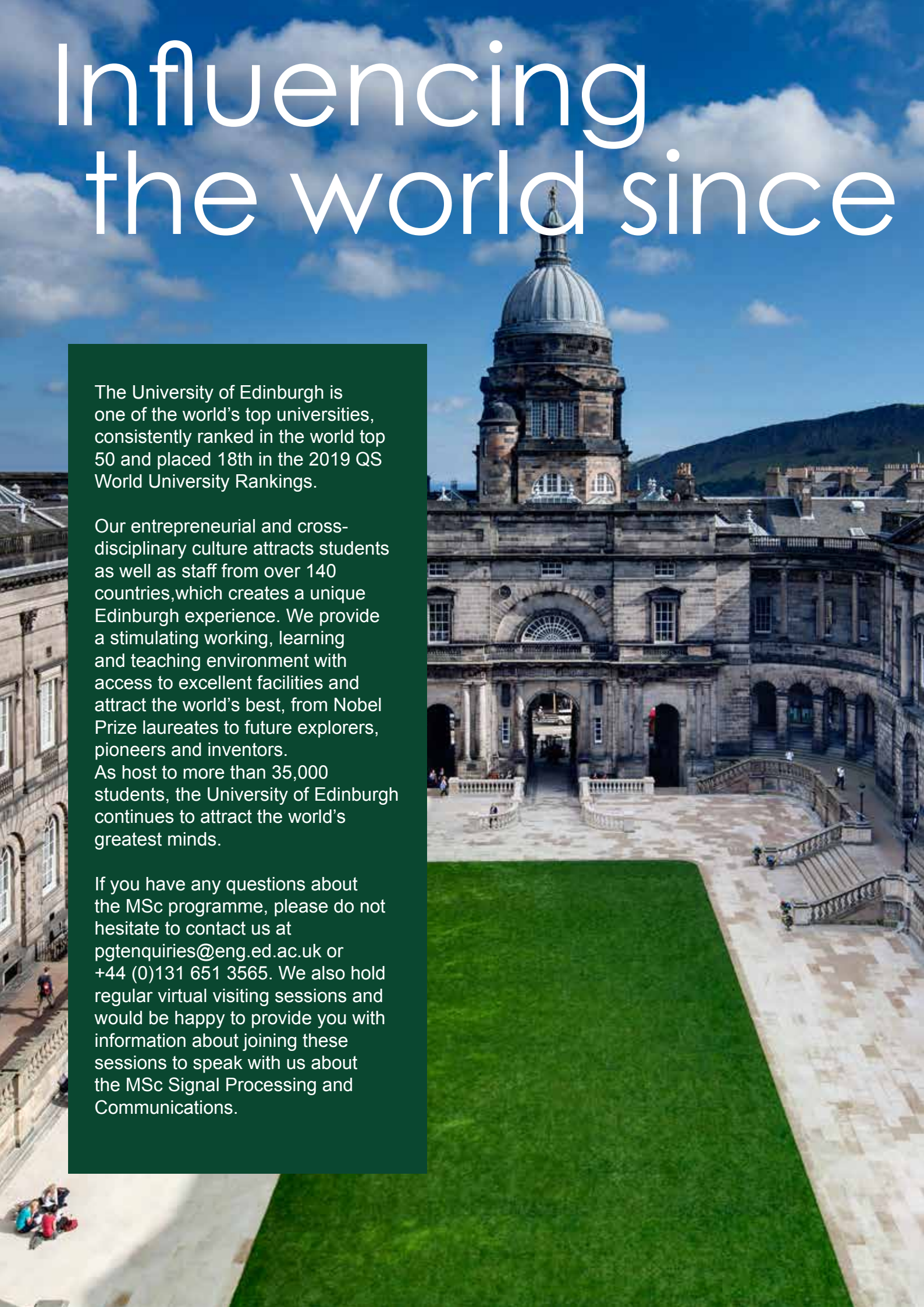
2019-2020

MSc Signal Processing and Communications

This programme provides graduates with specialist knowledge and the skills relevant to pursue a successful career in either industry or research. It will immerse you in recent developments in Signal Processing and Communication Engineering, including machine learning techniques.



Influencing the world since



The University of Edinburgh is one of the world's top universities, consistently ranked in the world top 50 and placed 18th in the 2019 QS World University Rankings.

Our entrepreneurial and cross-disciplinary culture attracts students as well as staff from over 140 countries,which creates a unique Edinburgh experience. We provide a stimulating working, learning and teaching environment with access to excellent facilities and attract the world's best, from Nobel Prize laureates to future explorers, pioneers and inventors.
As host to more than 35,000 students, the University of Edinburgh continues to attract the world's greatest minds.

If you have any questions about the MSc programme, please do not hesitate to contact us at pgtenquiries@eng.ed.ac.uk or +44 (0)131 651 3565. We also hold regular virtual visiting sessions and would be happy to provide you with information about joining these sessions to speak with us about the MSc Signal Processing and Communications.

Welcome from the MSc Programme Director

Thank you for your interest in the MSc programme in Signal Processing and Communications within the School of Engineering at the University of Edinburgh. We are one of the largest, most innovative and highly-ranked Schools in the University, holding a REF2014 research rating of No.1 in UK Engineering, having achieved the highest Research Power of any UK engineering submission.

Our MSc was established in September 2004 and, since then, over 350 students from 27 different countries have graduated from the programme. The School is one of the most industrially engaged in the University, with graduates providing a strong economic impact when they enter the workplace.

This one-year programme will immerse you in the most recent developments in Signal Processing and Communication Engineering, including advances in modern machine learning techniques. The programme will give you a unique opportunity to learn about the theoretical foundations of the subjects, as well as learning about advanced topics at the cutting edge of current research. Through the MSc research project, you will look at real-world signal processing problems to demonstrate practical applications and delve deeper into the underpinning theory.

We host regular virtual visits through the year to provide you with more information about the programme. These virtual visits will help you prepare for your degree by giving you an opportunity to speak with academics who lecture on the programme, hear more details about course content and the research projects on offer.

I look forward to meeting you in September.

Dr James Hopgood

Welcome From the Director of Discipline for Electronic and Electrical Engineering

The School of Engineering is proud to host a number of high quality degree programmes in the Electrical & Electronic Engineering (EEE) discipline, both at undergraduate and Masters level. Last year we had over 330 undergraduate students in Electrical Engineering from around the world, and over 100 students on EEE-related MSc programmes. These students were taught by over 30 research-active academic staff, including several industrial professors.

The vibrant set of MSc programmes included within our discipline covers Signal Processing & Communications, Sustainable Energy Systems, Electrical Power Engineering, and Electronics. These programmes give our students a unique opportunity to study their chosen field to an advanced level.

Our academic staff work across seven research institutes within the School of Engineering which covers Digital Communications, Bioengineering, Integrated Micro & Nano Systems, Energy Systems, Infrastructure & Environment, Multiscale Thermofluids and Materials & Processes. Over 300 PhD and Post-doctoral Research Associates are actively engaged in state-of-the-art research projects.

Our advanced research feeds into teaching through the MSc research projects, and up-to-date teaching materials and examples in our lecture courses. The School of Engineering continually invests in teaching, including increasing the number of teaching, support and technical staff, investing in equipment to support teaching and research projects, and ensuring lecture recording is available through the newly introduced University "Media Hopper Relay" service.

The School of Engineering is delighted that you are interested in our Masters in Signal Processing & Communications, one of our most dynamic and challenging programmes. I wish you every success in your studies.

Professor John Thompson

Introduction to the MSc Signal Processing and Communications

Signal processing and Communications provide the theoretical foundations for any application which generates, processes, transmits, or stores any type of signal, where the signal is typically acquired from a sensor. Practical examples are found on computers and smart phones, as well as powering the Internet and mobile communication systems. Applications also include UHD Blu-ray players and video streaming, autonomous vehicles, radar and surveillance systems, sensor networks, wearable sensors, medical imaging machines, human-computer interfaces (HCI), digital cameras, financial products, and many more.

This course is one of several in Europe which has a curriculum that covers both signal processing and communications in equal proportion. A key strength of our course is that we place an emphasis on fundamental concepts and how they relate to recent advances in both disciplines. We also use real-world system examples to demonstrate their practical application.

"We are consistently ranked in the top 50 universities in the world

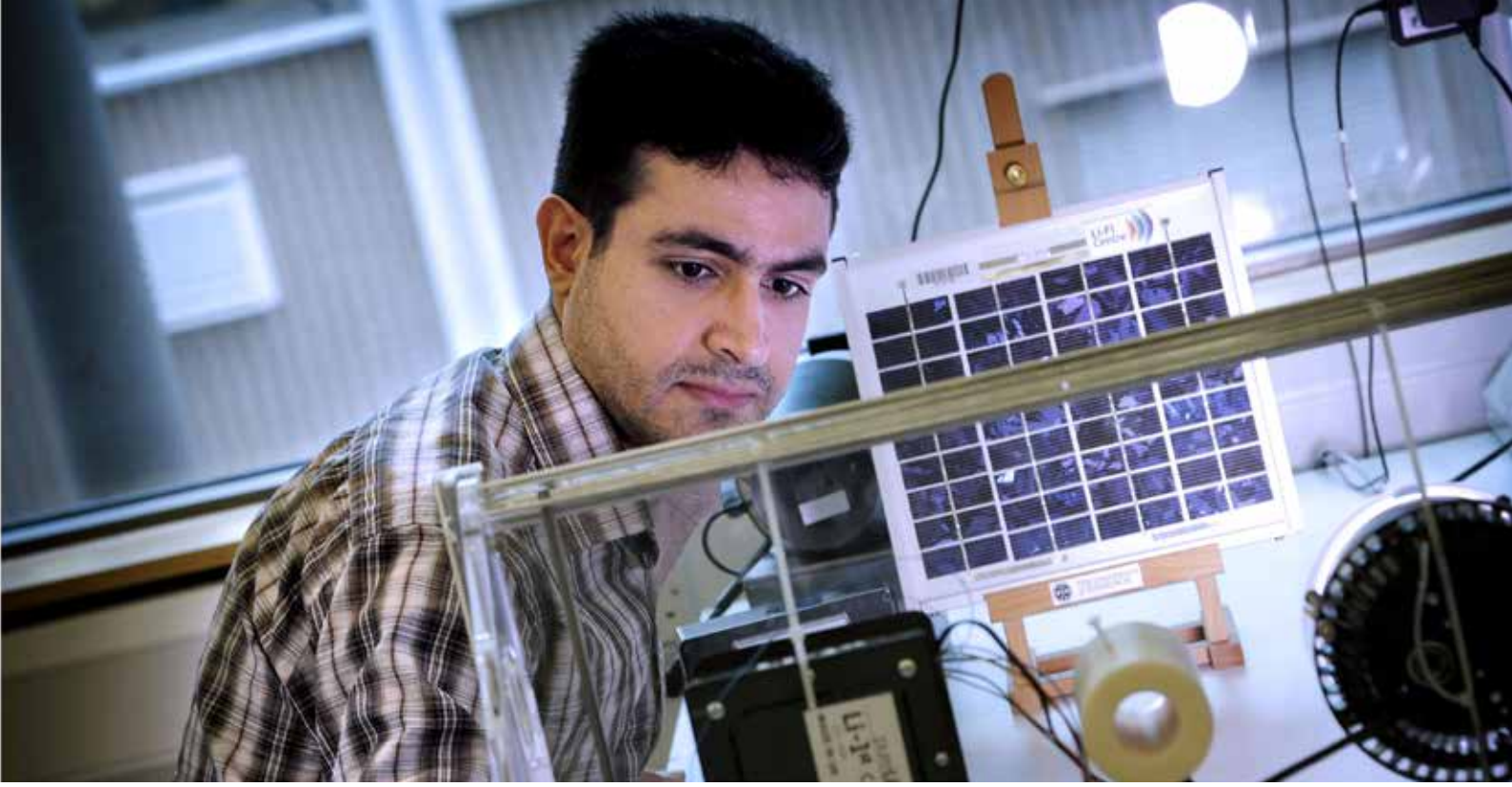
The course will appeal to graduates who wish to pursue a career in a range of industries such as communications, radar, medical imaging, HCIs, finance, data science and machine learning and wherever signal processing is applied. It is also suitable for graduates who wish to develop the specialist knowledge and skills relevant to this industry and as advanced study in preparation for research work in an academic or industrial environment, or in a specialist consultancy organisation. All lecture courses are at the cutting edge of research in this field.

Why Pursue a Signal Processing and Communications MSc at Edinburgh?

The University of Edinburgh is consistently ranked as one of the top universities in the world in the QS World Universities Rankings™. Academic staff who teach on the MSc Signal Processing and Communications programme are at the leading edge of some of the most exciting advances in Signal Processing, Communications, and Machine learning research. As part of the Electronics and Electrical Engineering discipline at Edinburgh, we have been awarded very high ratings for both teaching and research.

According to the most recent Research Excellence Framework (REF 2014), 94% of our research activity is rated as world leading or internationally excellent, making Edinburgh a UK powerhouse in Engineering.

In your summer research project, you will be placed in a world-class, stimulating environment, working on the cutting edge of the current technological developments, side by side with the leading researchers in the field here at the University of Edinburgh.
Xiaowen Dong, an MSc Signal Processing and Communications graduate had this to say:



"The most precious thing I obtained from this MSc course was the motivation and passion to study interesting problems in signal processing and communications, looking at familiar concepts from new perspectives, and discovering and solving novel challenges along the way. This was done by being lectured difficult concepts with clarity, solidifying them through practical exercises, and generalizing them in the context of real research problems. The MSc coverage of emerging and challenging topics of modern signal processing helped me tremendously while pursing my PhD at the Swiss Federal Institute of Technology (EPFL) and conducing research at MIT."

What Does the Degree Involve?

In our programme, you will learn a variety of subjects in signal processing and communications, from probability and estimation theory, to adaptive filtering, and state-of-the-art machine learning, and from the fundamentals of basic digital communications systems to modern wireless systems and multiple-input, multi-output systems.

This MSc degree involves two main elements, the taught component and the project. In the two taught semesters, students study ten lecture-based modules covering the theoretical foundations of signal processing & communications, in addition to two coursework based modules. This includes a computing module which uses MATLAB to investigate and understand signal processing algorithms, and preliminary project work prior to your main research project in the summer semester, which becomes full-time after the final examinations.

The programme has been designed with a slightly lighter course load in the first semester to help students who are new to the city of Edinburgh and the University acclimatise to your surroundings and a new university environment.

Teaching and Assessment Methods

The objectives of the programme are to develop an understanding of the fundamental principles in signal processing, communications, and machine learning, in scientific and technological terms, and develop the student's skills in learning.

Our aim is to equip the students sufficiently to enable further study in a research or professional environment. To facilitate this, the programme uses a broad range of teaching and learning methods, including lectures, tutorials and examples classes, laboratory sessions, in-depth project work, and final exams.

The lecture-based courses are designed to provide an efficient learning environment in which key issues can be highlighted and discussed within the class. Most courses include self-study questions, which are supplemented by a mixture of tutorials and interactive examples classes, and provide opportunities for formative feedback. Some courses include mock examinations to provide students the experience of sitting the assessment, without it contributing to the final mark.

Assessment varies from course to course and may involve a combination of continuously assessed coursework and an examination at the end of the semester, or be based on only one of these components.

The Digital Signal Processing Laboratory gives you a hands on opportunity to implement algorithms using a technical computing language, while the second semester project allows you to undertake a substantial literature review of a state-of-the-art research topic, while undertaking some preliminary research of your own.

A particularly strong emphasis is placed on using virtual learning environments, including the Learn® online systems for sharing lectures, video course materials, and lecture recordings.

> We are in the top 5 for research funding in the UK

Research Project

The MSc project is a practical research or design exercises. They give you the experience of applying knowledge and understanding gained in earlier study, as well as increasing your competence in a particular area of study. The objective output of a project is a novel design, or empirical knowledge, the extent of attainment of which forms part of the overall assessment. However, skills and attitudes appropriate to the professional engineer, developed in pursuit of the objective output, are just as important and are given corresponding weight in the assessment. The project work will develop your skills through applied research of a topic.

We run a fair project allocation scheme that aims to match your allocated project to your nominated research topics, which you will have chosen from a list of project descriptions, typically 100-200 words long.

Institute for Digital Communications

The MSc in Signal Processing and Communications is based in the Institute for Digital Communications (IDCOM). IDCOM comprises 15 academic staff, 20 postdoctoral research associates, and around 40 PhD students and has a long history of signal processing and communications research. The Institute was commended in the recent 2014 REF assessment for carrying out high quality research. The Institute has a research grant turnover of over £4M per annum.

IDCOM is internationally renowned for its contributions to signal processing and wireless communications. In the relevant field of wireless communications and sensor research spans the major areas, including:

- Machine learning and inference methods
- Compressive Sensing Techniques and Their Applications
- Radar and Synthetic Aperture Radar signal processing
- Wireless system performance analysis
- Cooperative multihop/relaying communication
- Interference avoidance/mitigation and radio resource allocation and scheduling
- Biomedical Signal and Image Processing
- Audio and Acoustic Signal Processing
- Optical wireless communications, and in particular Visible Light Communications
- Electrical Tomography

The research staff have strong multidisciplinary interests in all aspects of communications, signal and image processing, and machine learning methods. The environment encourages interaction between members of the group and other institutions. In particular, IDCOM collaborates closely with Heriot-Watt University, also located in Edinburgh, through the Joint Research Institute in Signal and Image Processing (JRI-SIP).

The Institute occupies the first 2 floors of the purpose-built Alexander Graham Bell Building which was completed in 2004 with £2.8M from the Science Research Infrastructure Fund. Through various research projects, IDCOM has a number of industrial partners: BAE Systems, Thales, Leonardo (SELEX/ES), Defence Science and Technology Laboratory (DSTL), QinetiQ,SeeByte Ltd. and Roke Manor. Work through these industrial partners often feeds into the topics for the research project that you will study in the second half of the programme. Often, several of our dissertation projects are co-formulated and co-advised by industrial partners, with the topics of the projects reflecting both the current technological challenges and the training needs of our MSc students.

Scholarships and Bursaries

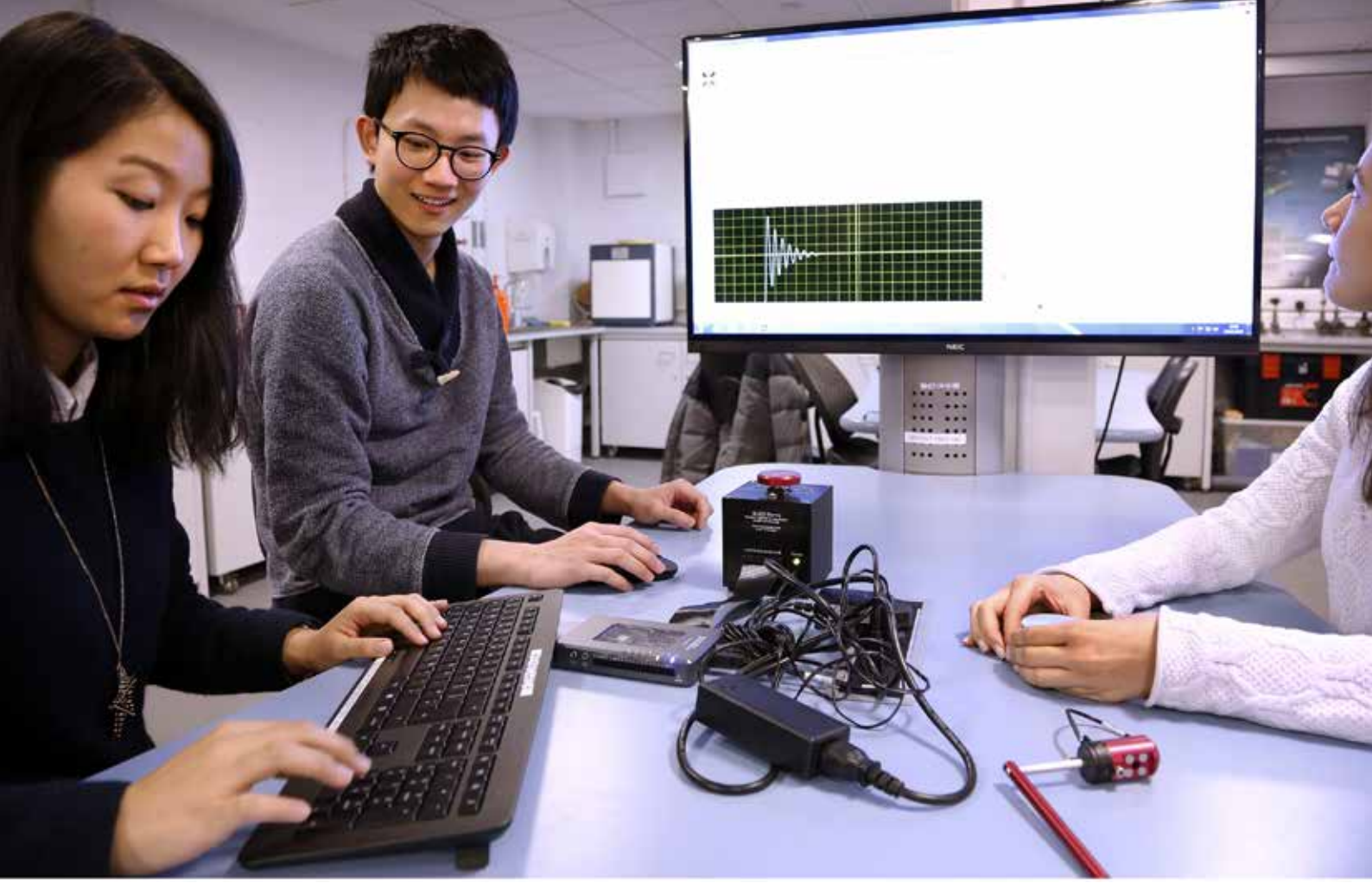
The School of Engineering offers several scholarships and bursaries alongside those offered by the University. For more information please visit: www.scholarships.ed.ac.uk.
To find a comprehensive list of the funding opportunities that are available to you, please use the search function on the Scholarships website, found at: www.ed.ac.uk/student-funding/search-scholarships.

What Can I do After my Degree?

A select number of top performing students who excel in their research project and demonstrate the critical thinking necessary to proceed to further study may be invited to apply for a PhD with us. For further information on PhD projects, please visit: www.eng.ed.ac.uk/postgraduate/degrees/phd.

For those graduates not interested in further studies, opportunities in industry can be explored through our Careers Service (www.ed.ac.uk/careers/postgrad/taught-pg). The Careers Service at the University of Edinburgh offers our graduates support throughout their degree and for two years afterwards.
Ranked 6th in the UK and 32nd in the world for employability*, the University of Edinburgh is an excellent choice for a postgraduate education with prospects.
*latest emerging Global Emplyability University Rankings

Within six months of finishing their MSc Signal Processing and Communications degree, some of our graduates were working with KPMG, Pure VL, Intel, Ericsson, SFC Technology and IBM China.



What are Admissions Staff Looking for?

You should have a 2.1 honours degree, or its international equivalent in electrical engineering with a specialisation in signal processing and/or communications. We will also consider your application if you have a background in a related field, such as computer sciences, physics or mathematics. Due to the competitive nature of this programme, you will need to have high grades in fundamentals such as mathematics, signals and systems, probability and statistics, and communications and signal processing.

You will find our most up-to-date entry requirements on the University of Edinburgh Postgraduate Online Degree Finder, found here: www.ed.ac.uk/pg/20. For further information about the application process please visit: www.ed.ac.uk/studying/postgraduate/applying or email the Postgraduate Taught Office at pgtenquiries@eng.ed.ac.uk.

If you would like to visit our campus, you can do this either in person or through a virtual visit. We run regular virtual visits throughout the year where you will have an opportunity to hear more about the University of Edinburgh and the School. of Engineering. If you wish, you can also speak to an academic who teaches on the Signal Processing and Communications MSc programme.

Where Are We Located?

The School of Engineering is located on the King's Buildings campus, which is situated on the south side of Edinburgh. Getting to and from King's Buildings is easy due to its excellent public transport, walking and cycling links. King's Buildings campus is approximately 2.5 kilometres from the Central Area and is extremely well served by the public bus system. The University provides a shuttle bus between the King's Buildings and the Central area during term time. For more information on travel please visit www.ed.ac.uk/transport/travelling-here

Every one of our departments conducts world-leading research

Edinburgh, a city of influence

Edinburgh is regularly voted as one of the best places to live in the world. Cobbled lanes, dramatic skylines and striking architecture combine to produce a stimulating setting for the writers, philosophers, political thinkers and inventors whose stories have been woven into the capital's fabric throughout history. The city's medieval Old Town and Georgian New Town, which offer contrasting history and architecture, have been designated a UNESCO World Heritage site.

With an array of museums, galleries, parks, gardens, pubs, clubs, restaurants, shops, theatres, cinemas, sports facilities and much more, you'll find something for every taste in the city. And not forgetting the biggest arts festival in the world, the Edinburgh Festival Fringe, which takes place in the city every August.

Well known for its friendly people, its safe, green environment and its stunning architecture, Edinburgh is a compact city, which makes it easy to get around. Wherever you are in the city, you are seldom far from open countryside and our central location and excellent transport links make it easy to travel to other parts of Scotland.

Edinburgh enjoys a creative and cultural significance that was further confirmed with its appointment as the world's first UNESCO City of Literature – a permanent title reflecting its recognition as a worldwide centre for literary activity. You couldn't ask for a more inspiring setting in which to further your knowledge and broaden your horizons.


DUGALD STEWART

Semester 1: September – December

Welcome Week

Semester 1

The compulsory courses taken this semester are Digital Communications Fundamentals (MSc). Discrete-time Signal Analysis (MSc), Digital Signal Processing Laboratory (MSc), Image Processing and Probability, Estimation Theory and Random Signals (PETARS) (MSc). There are no optional courses with this degree.

Thesis Project Selection

Exam Revision

Semester 1 Exam Diet

University closes for Christmas

Semester 2: January – April

University reopens after Christmas break

January Welcome Week

Semester 2: Application

The compulsory courses taken this semester are Adaptive Signal Processing, Machine Learning in Signal Processing, Advanced Coding Techniques (MSc), Advanced Wireless Communications (MSc), Array Processing and MIMO Systems (MSc), Pre-Dissertation Project in Signal Processing and Communications (MSc) and students will begin the Signal Processing and Communications Project and Thesis which will continue past into

Flexible Learning Week

Semester 2 resumes

Spring Vacation

Revision Week

Semester 2 Exam Diet

Dissertation: May - August

Dissertation

Dissertation Submission


100
11:10
17/02/2016

Course Information

Taught in Semester 1

Image Processing (10 credits)

2 Lecture hours; 1 Tutorial hour per week

You will study elements of image processing theory and application through the application of signal processing techniques. The syllabus of the course is:

- Introduction: Basic concepts of vision and images
- Image transforms: SVD, Haar, Walsh, Fourier and derived methods
- Statistical description of images, including the Karhunen-Loeve Transform
- Image enhancement: Filters, Removing noise and interference, Histogram manipulation
- Image restoration: including inverse and Wiener filters
- Image segmentation and edge detection
- Image processing for multispectral images

Digital Signal Processing Laboratory (MSc) (10 credits)

3 Practical hours per week

This course will teach you to solve simple problems in the areas of communications and signal processing in a MATLAB environment. The course will reinforce material taught in the co-requisite courses and provide practical experience of signal and image processing implementation in preparation for the project. The course will be composed of programming sessions and course assignments covering discrete time signal analysis, communications and image processing.
Course contents:

- A set of assessed programming sessions run weekly covering:
  - Introduction to signal processing in MATLAB
  - Generating time domain signals
  - Simulating continuous and sampled signals
  - Calculating the DFT, its properties and implementation
  - Signal and image filtering
  - Power spectral density estimation
- Course assignments to be completed outside of lab hours. Example exercises could be: simulating an adaptive noise cancellation problem, estimating frequencies and noise power in a time domain signal, simulating a simple modulation / demodulation and detection scheme

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Discrete-time Signal Analysis (MSc) (10 credits)

2 Lecture hours; 1 Tutorial hour per week

You will study the theory, and the practical application, of statistical analysis to signals and systems described by random processes. The topic will be approached from both time and frequency domains with an emphasis on studying the effect that analysis tools have on the resulting analysis. The course provides in-depth coverage of the discrete Fourier transform, and its role in spectrum estimation, as well as the design of finite impulse response filters, and their role in signal identification. In particular, issues such as resolution and dynamic range of an analysis system are dealt with, to give you an appreciation of how to apply the theory to engineering problems.

You will explore the analysis of practical signals through time and frequency analysis techniques, and understand the effect of each step in the process. After successful completion of this course you should be able to:

- explain the relationships between and be able to manipulate time domain and frequency domain representations of signals
- apply correlation techniques to an analytic or numerical problem, and relate the outcome to the statistical properties of the signal source(s)
- correctly define probability density functions and cumulative distribution functions, and be able to manipulate them to find moments of random variables and their sums
- define the distinctions between wide-sense stationary, stationary, and ergodic processes, and be able to reason to which category a random process belongs
- derive the power spectrum of a signal
- define techniques for calculating moments in spectral and temporal domains
- explain the importance of linear phase filter design and apply time and frequency techniques to design a FIR filter
- evaluate power spectral density at the output of a linear filter given the PSD at the input
- recognise the effect of resolution and windowing functions upon the discrete Fourier transform
- analyse the effects of downsampling and upsampling on a signal and recognise the importance of decimation and interpolation filtering
- explain the basis of matched filtering and be able to determine an appropriate filter for a given problem
- apply a Wiener filter to the detection of a signal corrupted by additive noise, and for signal prediction

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Digital Communication Fundamentals (MSc) (10 credits)

2 Lecture hours; 1 Tutorial hour per week

The aim of this course is to provide you with a thorough understanding of how information theory relates to the design of digital communications systems and to provide the knowledge and skills to perform design calculations on these systems. You will use standard mathematical methods to model and analyse digital communication systems and predict performance metrics such as received SNR and expected bit error ratio.

Upon completion of the course you should be able to:

- understand sources of noise in a communications system and statistical techniques for describing noise
- comprehend application of some common decision rules in digital communications receivers
- understand multiplexing and basic PCM speech coding
- explain the principles of linear predictive speech coding
- understand information theory and design block error correcting coders
- perform error rate calculations based on decision criteria
- understand the basic techniques for source coding and drawbacks of common techniques
- comprehend the uses of forward error correcting coding and the concept of block codes
- understand the application of block coding techniques as well as some fundamental limits on their performance
- comprehend the convolutional codes and the Viterbi decoding algorithm
- analyse the performance of ASK, FSK, PSK IF coding in terms of occupied bandwidth, complexity etc
- perform error rate calculations
- understand extension to QPSK, MPSK, QAM for improved spectral efficiency
- perform error rate calculations
- derive receiver noise performance, free space link path loss and perform receiver noise predictions on terrestial receiver systems
- extend to satellite based systems with low noise cooled earthstations
- appreciate industrial importance of networks, ATM and IP protocols
- comprehend the basic concepts of personal mobile communications and in particular GSM European TDMA systems
- comprehend the basic concepts of spread spectrum techniques as used in mobile personal communications
- understand operation of network protocols such as ARQ
- comprehend queueing concepts, delays, Littles result
- describe telephony multiplex systems using PDH and SDH
- perform efficiency calculations on these systems; Understand operation of wireless LANs and PANs.

Probability, Estimation Theory and Random Signals (PETARS) (MSc) (20 credits)

4 Lecture hours; 2 Tutorial hours per week

The Probability, Estimation Theory, and Random Signals course introduces the fundamental statistical tools that are required to analyse and describe advanced signal processing algorithms within the MSc Signal Processing and Communications programme. It provides a unified mathematical framework which is the basis for describing random events and signals, and how to describe key characteristics of random processes.

The course covers probability theory, considers the notion of random variables and vectors, how they can be manipulated, and provides an introduction to estimation theory. It is demonstrated that many estimation problems, and therefore signal processing problems, can be reduced to an exercise in either optimisation or integration. While these problems can be solved using deterministic numerical methods, the course introduces the notion of Monte Carlo techniques which are the basis of powerful stochastic optimisation and integration algorithms. These methods rely on being able to sample numbers, or variates, from arbitrary distributions. This course will therefore discuss the various techniques which are necessary to understand these methods and, if time permits, techniques for random number generation are considered.

The random signals aspect of the course considers representing real-world signals by stochastic or random processes. The notion of statistical quantities such as autocorrelation and auto-covariance are extended from random vectors to random processes (time series), and a frequency-domain analysis framework is developed. This course also investigates the effect of systems and transformations on time-series, and how they can be used to help design powerful statistical signal processing algorithms to achieve a particular task.
The course introduces the notion of representing signals using parametric models; it extends the broad topic of statistical estimation theory for determining optimal model parameters. In particular, the Bayesian paradigm for statistical parameter estimation is introduced. Emphasis is placed on relating these concepts to state-of-the-art applications and signals. This course provides the fundamental knowledge required for the advanced signal, image, and communication courses in the MSc course.

Taught in Semester 2

Adaptive Signal Processing (10 credits)

2 Lecture hours; 1 Tutorial hour per week

This course deals with adaptive filters and related linear estimation techniques such as the Wiener infinite impulse response filter and Kalman filters. The concepts of training and convergence are introduced and the trade-off between performance and complexity is considered. The application of these techniques to problems in equalization, coding, spectral analysis and detection is examined.

On completion of this course, you will be able to:

- perform simple spectral factorization tasks and calculate noise component at output of discrete time filters
- derive and apply the principle of statistical orthogonality and design Wiener infinite impulse response (IIR) filters
- derive the scalar Kalman filter and apply the vector Kalman filter
- derive the least mean squares (LMS) and recursive least squares (RLS) adaptive filter algorithms and apply them to problems in system identification, linear predication and equalization
- derive and apply the spatially variant apodization (SVA)

Machine Learning in Signal Processing (10 credits)

2 Lecture hours; 1 Tutorial hour per week

This course aims to introduce techniques for performing pattern recognition, classification and adaption in the analysis of complex signals and data sets. The concepts covered are:

- classification and recognition
- statistical Inference and learning
- clustering
- feature selection and data reduction (e.g. PCA, ICA)
- blind signal separation

You will acquire an understanding of pattern recognition and adaptive methods and will learn how to apply these methods to the processing of a broad class of signals. By the end of the module you will be able to:

- recall a range of techniques and algorithms for pattern recognition and intelligent processing of signals and data, including neural networks and statistical methods
- derive and analyse properties of these methods
- discuss the relative merits of different techniques and approaches
- implement some of these techniques in software (e.g. Matlab)
- apply these methods to the analysis of signals and data

Advanced Coding Techniques (MSc) (10 credits)

2 Lecture hours per week; 2 biweekly Tutorials hours

This course will cover the current topics of interest in Advanced Coding Techniques. In particular information theory fundamentals related to source coding and its extension to channel capacity are studied. Rate-distortion theory and quantisation for uncorrelated and correlated signals are of particular interest. By the end of this course you will understand fundamentals as well as advanced concepts in source coding. You will be able to quantify the bit rate that is theoretically needed to perform source coding of continuous-valued signals with some given maximum distortion. You will be able to explain the complexity-quality trade-offs in practical systems and will be able to quantify how close practical quantisation algorithms can get to the theoretical limits given by information theory. You will be able to design scalar and vector quantisers for practical signals. You will also understand how information theory can be used to predict the data capacity of communications channels.

Advanced Wireless Communications (MSc) (10 credits)

2 Lecture hours per week; 2 biweekly Tutorial hours

This course will cover the current topics of interest in Advanced Wireless Communications, including:

- the wireless channel
- point-to-point communication: detection, diversity and channel uncertainty
- cellular systems: multiple access and interference management
- capacity of wireless channels
- multiuser capacity and opportunistic communication
- MIMO I: capacity and multiplexing architectures
- MIMO II: diversity-multiplexing trade-off and universal space-time codes

Practical examples of the above concepts are presented throughout the course. Upon completion of the course you will understand fundamentals as well as advanced concepts in wireless communications. You be able to understand the wireless channel characteristics and modelling; wireless communication concepts and techniques; and application of these concepts in a cellular system context. You will be able to learn the recent developments such as opportunistic and multiple input multiple output (MIMO) communication techniques. These techniques have brought completely new perspectives on how to communicate over wireless channels. You will be able to quantify the wireless channel capacities and degrees of freedom regions for different channel models, such as point-to-point channels, multiple access channels, broadcast channels, interference channels, etc. Finally, you will be able to design and analysis the cellular systems, for example interim of spectral and energy efficiencies, coverage, etc.

Array Processing and MIMO Systems (MSc) (10 credits)

2 Lecture hours; 1 Tutorial hour per week

This course will cover the current topics of interest in Array Processing and MIMO systems.

- Introduction
- signal Model (1D and 2D or 3D arrays)
- beamforming (Conventional, optimum and adaptive beamformers, Capon method, MSE based beamforming, LCMV beamformers)
- source Localisation (Conventional techniques, Subspace methods such as MUSIC, Root- MUSIC, ESPRIT)
- detection of number of signals (MDL and AIC methods)
- MIMO Systems: Channel Modeling and Spatial Multiplexing
- maximum Likelihood Parameter Estimation

Practical examples of the above concepts are presented throughout the course. You will understand fundamentals as well as advanced concepts in array processing and MIMO Systems. You will be able to learn the recent developments such as opportunistic and multi-user multiple input multiple output (MIMO) communication techniques. These techniques have brought completely new perspectives on how to communicate over wireless channels. You will be able to quantify the wireless channel capacities and degrees of freedom regions for different channel models, such as multiple access channels, broadcast channels, interference channels, etc. Finally, you will be able to design and analysis the advanced cellular systems, for example interim of spectral and energy efficiencies, coverage, etc.

Pre-Dissertation Project in Signal Processing and Communications (MSc) (10 credits)

This course covers and assesses the initial phase of a Masters research project.

The project topic is defined and you will then be expected to perform an initial literature review. You should also carry out preliminary project tasks in preparation for the main phase of the project itself. Finally you should also outline a proper programme of work for the main project, addressing any potential risks or pitfalls.

The work carried out in this course will be written up in the form of an interim report, which will be submitted at the end of the course.

Signal Processing & Communications: Project and Thesis (60 credits)

Dissertation.; this course is the project and thesis element of the MSc project.

You will do a substantive project in a topic relevant to signal processing and communications and generate a thesis detailing your results. The course will be assessed by consideration of your practical work via your lab notebooks and by the quality of the submitted thesis. A short viva will form part of the assessment of the thesis.

The University of Edinburgh is ranked 18th in the world by the QS World University Rankings 2019.

Contact Us

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