Electronic and Electrical Engineering

Information for modules taught in 2014-15.

All programmes and modules are reviewed annually and delivery in future years is subject to change.

Certificate Level (Year 1)

BEng/MEng Elec + Elec Eng-LC

BEng/MEng

Choose 20 credits from the section options 1

Year Credits: 120
Total Credits: 360/480

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE1A	0419509	Digital Logic and Microprocessor Systems	20	1+2
EE1B	0419502	Circuits, Devices and Fields	20	1+2
EE1C2	0411181	Introduction to Electrical Engineering	10	2
EE1D	0417022	Techniques of Analysis and Modelling	20	1+2
EE1E	0419503	C Programming and Algorithmic Problem Solving	20	1+2
EE1G1	0623521	First Year Group Project	10	1

Options 1

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE1F1	0411186	Introduction to Information Engineering	10	1
EE1F2	0411187	Multimedia Data	10	2
MOMD1 LC	Various	Module Outside the Main Discipline 1 LC	10	1or2
MOMD2 LC	Various	Module Outside the Main Discipline 2 LC	10	1or2

Progress Requirements

In order to proceed to the second year of study students are required to have passed: a) at least 100 credits. b) all modules that are pre-requisites for the modules in their second year. (i.e. EE1A, EE1B, EE1C2, EE1D and EE1E).

EE1A Digital Logic and Microprocessor Systems

20 Credits
Semester 1+2
Compulsory

Description: (EE1A1) Students are introduced to the theory and practice of logic, digital circuit design and digital representation of information. (EE1A2) Students are introduced to the design sequential logic circuits and to the principles of linear sequential systems. Students are introduced to assembler programming and microprocessor interfacing using the PIC range of microcontrollers.

Assessment:

75% EE1A Exam

3 hour exam in May/June, answer 4 questions from 6

25% Assessed Laboratories

Objectives:

EE1A1
On successful completion of this module, the student will be able to:
- Perform manipulations of Boolean logic expressions
- Use Karnaugh maps to transform boolean expressions to a logic circuit
- Design, build and test combinational logic circuits
- Use 2's complement arithmetic
- Describe and apply the behaviour of flip flops and latches.

EE1A2
On successful completion of this module, the student will be able to:
- Design and build simple Arithmetic Logic Units
- Write simple assembler language programs
- Interface a microcontroller to the real world
- Explain the principles of operation of the main building blocks of a computer.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE1B Circuits, Devices and Fields

20 Credits
Semester 1+2
Compulsory

Description: (EE1B1) Students are introduced to the physics of conduction in solids and the effects of electric fields. The terminal characteristics of basic devices are derived from first principles. The behaviour of nonlinear semiconductor devices is introduced. The underlying physical mechanisms are discussed quantitatively.
(EE1B2) The principles of AC and DC operation of circuits are examined. Students learn the theory and practice of analogue circuit design using op-amps and discrete transistors.

Assessment: **85%** **EE1B Exam**
3 hour exam in May/June, answer 4 questions from 6
15% **Coursework**

Objectives: EE1B1
On successful completion of this module, the student will be able to:
- Calculate the electric field and potential around a charge distribution for simple geometries.
- Derive the resistance and capacitance of simple structures.
- Describe the mechanism of conduction in solids, and perform calculations on the conductivity of materials.
- Describe physically the dc basic behaviour of diodes, MOSFETs and BJTs.

EE1B2
On successful completion of this module, the student will be able to:
- Use Kirchoff's laws to solve simple linear circuits, using mesh and nodal analysis
- Use Kirchoff's laws to solve circuits at sinusoidal steady state
- Apply Thevenin's and Norton's theorems to simple linear circuits.
- Design and build a range of different types of amplifier circuit using op amps, including inverting, non-inverting, summing amplifiers, and differencing amplifiers, and differentiator and integrator circuits
- Design simple amplifiers based on BJTs and FETs.
- Use a circuit simulation CAD package to design simple linear circuits.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE1C2 Introduction to Electrical Engineering

10 Credits
Semester 2
Compulsory

Description: Methods for treating electromagnetic forces and torques are introduced, and are applied to the principles of DC machines. The effects of magnetic saturation are introduced. The flow of power and storage of energy in LCR components is examined. The concept of rms values is introduced.

Assessment: **80%** **EE1C2 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
20% **Labs - Lab Report**

Objectives: On successful completion of this module, the student will be able to:
- Use magnetic equivalent circuit techniques and be able to apply them to simple magnetic structures and explain basic aspects of transformer design;
- Describe the basic principles of a DC machine and its equivalent circuit;
- Derive from first principles expressions for the energy stored in L and C components;
- Explain the principle of rms values

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE1D Techniques of Analysis and Modelling

20 Credits
Semester 1+2
Compulsory

Description: (EE1D1) Students are introduced to the application of mathematical techniques to engineering problems. The application examples are reinforced by problem solving classes.
(EE1D2) Students' knowledge and skills in the application of differentiation and integration are extended. Students are introduced to the principles and practice of the construction and solution of ordinary differential equations.
Partial derivatives are introduced, and applied to functions of two variables. The application of differential equation techniques to a range of important engineering problems is introduced.
9 hours of tutorials will be available with marks being given for attendance. Tutorial work will be handed to be marked and an effort mark given.

Assessment:

75% **EE1D Exam**
3 hour exam in May/June, answer 4 questions from 6
20% **Class Tests**
5% **Tutorials**

Objectives: EE1D1

On successful completion of the module, students will be able to formulate and solve problems in
- circuit theory,
- computer graphics,
- basic mechanics and
- signals & systems

using the following techniques
- the algebra of matrices and determinants;
- complex numbers;

EE1D2
On successful completion of this module, the student will be able to:
- Recognise standard forms of ordinary differential equations of first and second order, and solve them by appropriate techniques;
- Differentiate and integrate standard functional forms;
- Construct Taylor series
- Calculate partial derivatives
- Derive the equations corresponding to a range of important engineering situations. Solve these equations, and interpret the solutions.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE1E C Programming and Algorithmic Problem Solving

20 Credits
Semester 1+2
Compulsory

Description: (EE1E1) Students are introduced to the functional behaviour of digital computer systems. The course covers basic concepts of computer logic and architecture, algorithmic problem solving, programming structure, control and data organisation. The requirements for procedural programming languages are explained through the introduction of the syntax and semantics of the C programming language. (EE1E2) Students explore in further depth the advanced concepts of the C programming language, and are introduced to basic algorithmic decomposition and design

Assessment:

10%	**EE1E1 Lab sheets 4 & 5**
10%	**EE1E1 Lab sheets 6 & 7**
20%	**EE1E2 Lab exercise 4 & 5**
20%	**EE1E2 Assignment**
20%	**EE1E1 Class Test**
20%	**EE1E2 Class Test**

Objectives:

EE1E1
On successful completion of this module, the student will be able to:
- Describe the basic operation of a computer and understand the basic concepts of computer programming languages
- Design and test computer programs, using the basic constructs of the ANSI C programming language
- Understand elementary numerical methods (e.g. precision & errors) and their relationship to programming

EE1E2
On successful completion of this module, the student will be able to
- Apply more advanced C programming concepts such as pointers and dynamic memory allocation
- Understand and apply the principles of algorithmic decomposition and design
- Develop high-quality software written in the C programming language

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE1F1 Introduction to Information Engineering

10 Credits
Semester 1
Options 1

Description: Students are introduced to the elements of information theory and its application to the design of communication systems.

Assessment:
75% **EE1F1 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
25% **Lab Report**

Objectives: On successful completion of this module, the student will be able to:
- Describe the main elements of a communication system.
- Describe the main features of a variety of physical communication mechanisms (e.g. radio & microwave, optical fibre, coaxial cable), identifying sources of noise and error, explaining factors limiting bandwidth, and explaining the need for modulation of signals.
- Apply the basic concepts of information theory.
- Perform basic information theory calculations.
- Construct simple error detecting codes.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE1F2 Multimedia Data

10 Credits
Semester 2
Options 1

Description: The aims of this module are :- To introduce students to the properties of the various types of multimedia data that enable them to be efficiently manipulated, compressed and transmitted. To introduce students to techniques of image, video and audio coding and to introduce aspects of multimedia and interactive web pages.

Assessment:
100% **EE1F2 Exam**
1.5 hour exam in May/June, answer 2 questions from 3

Objectives: On successful completion of this module, the student will be able to:
- Perform simple low level image processing
- Describe the main coding methods used for different types of data, and explain their advantages and disadvantages.
- Interpret frequency spectra of signals
- Explain why and how some of the information in an auditory or visual data stream may be discarded without loss of perceived quality.
- Understand the rate/distortion trade-off for lossy compression and the importance of error-free communication for compressed information.
- Appreciate elements of interactive web-based multimedia encoding involving, for example, JavaScript and Scalable Vector Graphics.

Pre-Requisites: EE1G1 **Co-Requisites:** None **Prohib Combs** None

EE1G1 First Year Group Project

10 Credits
Semester 1
Compulsory

Description: The module introduces students to basic aspects of professional engineering, such as project management, team-work, design skills. The module is the first of several modules that deal with employability and professional engineering / project work (the 'G' modules occur in year 2 and the Project work in years 3 and 4). The course introduces students to aspects of employability, such as CV writing, and professional society accreditation. A novel aspect of the course lies in the group project that involves the design and specification of a multi-platform application.

Assessment:

10%	**Individual essay**
15%	**Group specification**
50%	**Group poster presentation**
25%	**Group record of team meetings**

Objectives: By the end of the module the student should be able to:
- Demonstrate effective team working and design skills
- Demonstrate presentation skills

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

Intermediate Level (Year 2)

BEng/MEng Elec + Elec Eng-LI

BEng/MEng

Choose 20 credits from the section Options 1

Year Credits: 120
Total Credits: 360/480

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE2A	0419504	Digital Systems and Embedded Computing	20	1+2
EE2B	0419505	Electronic Circuits, Devices and Electromagnetics	20	1+2
EE2C	0419506	Electrical Energy Systems and Control	20	1+2
EE2D1	0417024	Fundamentals of Signals and Systems	10	1
EE2D2	0413812	Communication Systems	10	2
EE2G	0424091	Project Management and Professional Practice	20	1+2

Options 1

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE2F	0419508	Multimedia: Speech, Audio Processing and Music	20	1+2
EE2F2	0425590	Multimedia: Music Technology	10	2
EE 2EPR	0422725	Electrical Power	10	1
MOMD1 LI	Various	Module Outside the Main Discipline 1 LI	10	1or2
MOMD2 LI	Various	Module Outside the Main Discipline 2 LI	10	1or2

Progress Requirements

In order to proceed to BEng 3 students are required to have:
a) attempted all pre-requisite modules (i.e. EE2A, EE2B, EE2C and EE2D1);
b) passed at least 100 credits at level 2; and
c) passed at least 200 credits overall.

To proceed to MEng 3 students must pass 220 credits over all, including all pre-requisite modules, and have a second year average of at least 60%.

Transfer Opportunities

None.

EE2A Digital Systems and Embedded Computing

20 Credits
Semester 1+2
Compulsory

Description: (EE2A1) The module aims to provide an in-depth understanding of the design and implementation of finite state machines and an introduction to the use of C programming for embedded computing. (EE2A2) Students deepen their understanding of the design of synchronous and asynchronous digital systems, and undertake a series of case studies using programmable logic devices. Students deepen their understanding embedded microcontrollers and communication protocols used by computers.

Assessment:

75% **EE2A Exam**

2 hour exam in May/June, answer 3 questions from 4

25% **Assessed Laboratories**

Objectives:

(EE2A1)
On successful completion of this module, the student will be able to:

- Design synchronous finite state machines.
- Implement synchronous finite state machine using a programmable logic device.
- Write programs for embedded microcontrollers, and interface the microcontroller to support circuitry.

(EE2A2)
On successful completion of this module, the student will be able to:

- Design and implement complex synchronous and asynchronous digital systems
- Design interfacing circuitry for communication between microprocessors and peripherals.
- Write C programmes for embedded microcontrollers that control peripheral hardware.

Pre-Requisites: EE1A & EE1E **Co-Requisites:** None **Prohib Combs** None

EE2B Electronic Circuits, Devices and Electromagnetics

20 Credits
Semester 1+2
Compulsory

Description: (EE2B1) Students deepen their understanding of electronic circuits, with a more in-depth consideration of linear circuits (in particular the most important amplifier configurations), examination of non-ideal effects, and consideration of nonlinear circuits. Students deepen their understanding of the behaviour of solid state electronic devices.
(EE2B2) Students deepen their understanding of electrostatics and magnetostatics, and are introduced to electromagnetics. The behaviour of time varying signals along transmission lines is introduced, and important applications are considered.

Assessment: **85%** **Exams**

1.5 hour exam in May/June, answer 2 questions from 3

1.5 hour exam in May/June, answer 2 questions from 3

15% **Assessed Laboratories**

Objectives: (EE2B1)

On successful completion of this module, the student will be able to:
- Design circuits based on the common emitter bipolar transistor amplifier.
- Design circuits based on the differential amplifier.
- Calculate the frequency response of an op-amp amplifier in a variety of configurations.
- Design a comparator circuit
- Derive the current-voltage characteristics of a semiconductor diode from first principles.
- Use Gauss' law and Poisson's equation to determine the spatial dependence of field and potential within depletion layers.
- Derive the current-voltage characteristic of short channel MOSFETs

(EE2B2)

On successful completion of this module, the student will be able to:
Formulate and solve equations relating to
- the electric field around a charge distribution
- the magnetic field around a current density distribution
- propagation of electromagnetic fields in free space
- the electromagnetic field within a transmission line

Use Smith charts to carry out designs of high frequency circuits

Pre-Requisites: EE1B & EE1D **Co-Requisites:** None **Prohib Combs** None

EE2C Electrical Energy Systems and Control

20 Credits
Semester 1+2
Compulsory

Description: (EE2C1) Important principles of modern power-electronics for the conversion and control of electrical power are discussed together with the basic building blocks of power systems and modern motors and drives. The necessary analysis is drawn in and the systems aspects emphasised.
(EE2C2) Students learn fundamental methodologies and techniques for qualitative and quantitative analysis of signals and systems. These are illustrated using examples of typical physical systems, especially control systems, and applicable to power and information processing and process control.

Assessment: **80%** **EE2C Exam**
3 hour exam in May/June, answer 4 questions from 6
20% **Assessed Laboratories**

Objectives: (EE2C1)

On successful completion of this module, the student will be able to:
• Analyse single-phase, phase controlled converters operating in continuous conduction mode.
• Design and quantitatively evaluate non-ideal transformers, brushless DC motors, induction motors, principles of power transfer and voltage control in power systems

(EE2C2)

On successful completion of this module, the student will be able to:
• Describe the main concepts underlying the dynamics of linear and time- invariant systems.
• Derive and solve the differential equations for systems involving R, L, C, masses, springs and dampers, simple DC machines, simple fluid flow and heat transfer.
• Apply Laplace transform to obtain system responses to typical signals
• Derive transfer functions and pulse transfer functions for systems with feedback
• Organise system equations into state-space format and derive the time-domain solution.
• Derive dynamical properties of continuous - time and discrete-time systems by analysing its poles, zeros and frequency response functions
• Derive dynamical properties of sampled data systems with zero order hold interpolation
• Apply Fourier transforms to calculate power spectrum and energy spectrum of continuous and sampled signals.

Pre-Requisites: EE1B, EE1C2 & EE1D **Co-Requisites:** None **Prohib Combs** EE2C2

EE2D1 Fundamentals of Signals and Systems

10 Credits
Semester 1
Compulsory

Description: The aim of the modules is to provide an understanding and computational experience in use of the relevant mathematics necessary for analysis of signals and systems. Students' learning is reinforced by problem solving classes and MATLAB computer laboratories. The module is a corequisite for second semester control and communication modules.

Assessment:
80% **EE2D1 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
20% **Coursework Assignment**

Objectives: On successful completion of this module, the student will be able to:
- Understand the application and uses of the Fourier Series and Fourier Transform;
- Understand the application and uses of the Laplace Transform to solve ordinary and partial differential equations in the s-domain;
- Understand the application and uses of the z-Transforms to solve difference equations in the z-domain;
- Apply concepts of statistics and probability to acquired signals.

Pre-Requisites: EE1D **Co-Requisites:** None **Prohib Combs** None

EE2D2 Communication Systems

10 Credits
Semester 2
Compulsory

Description: The main features of communication systems are examined in detail. Students are introduced to the key issues in filter design. Different modulation schemes are contrasted. The role of noise is examined.

Assessment:
80% **EE2D2 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
20% **Coursework Assignment**

Objectives: On successful completion of this module, the student will be able to:
- Explain the operation of telephone switching systems and perform traffic calculations
- Apply Shannon's theory to calculate channel capacity
- Estimate the effect of noise on digital signals.
- Explain the functions of regenerators and eye diagrams.
- Explain and perform calculations on matched filtering.
- Explain and perform calculations on sampling and quantisation.
- Design passive filters.
- Relate modulated signals to their baseband counterparts, both in the time and frequency domains.
- Explain the noise model for narrowband signals, and use it in calculations.

Pre-Requisites: EE1D & EE2D1 **Co-Requisites:** None **Prohib Combs** None

EE2F Multimedia: Speech, Audio Processing and Music

20 Credits
Semester 1+2
Options 1

Description: (EE2F1) Students are introduced to the issues involved in the electronic processing of audio and speech data. (EE2F2) Students are introduced to the key features of music technology.

Assessment:

80% **EE2F Exam**
2 hour exam in May/June, answer 3 questions from 4

20% **Assessed Laboratories**

Objectives: (EE2F1)

On successful completion of this module, the student will be able to:

- Generate and interpret speech spectrograms, take basic measurements from them, and estimate formant frequencies;
- Explain the physiological and acoustic aspects of human speech production and perception, and apply phonetic models for speech production;
- Explain the principles of speech synthesis and coding techniques and select appropriate technique for a particular application
- Estimate the bandwidth required for different speech coding techniques;
- Explain the principles of speech recognition by computers
- Use software tools to convert a text input to an acoustic waveform.

(EE2F2)

On successful completion of this module, the student will be able to:

- Explain the principles underlying the various components in music technology systems, to contrast their strengths and weaknesses, and to critically evaluate which methods are appropriate for particular applications.

Pre-Requisites: EE1F1 & EE1F2 are preferred, but not required

Co-Requisites: None

Prohib Combs EE2F2

EE2F2 Multimedia: Music Technology

10 Credits
Semester 2
Options 1

Description: Students are introduced to the key features of music technology.

Assessment: 80% by 1.5 hour exam in May/June, answer 2 questions. 20% by assessed laboratory.

Objectives: On successful completion of this module, the student will be able to:

- Explain the principles underlying the various components in music technology systems, to contrast their strengths and weaknesses, and to critically evaluate which methods are appropriate for particular applications.

Pre-Requisites:

Co-Requisites: None

Prohib Combs EE2F

EE2G Project Management and Professional Practice

20 Credits
Semester 1+2
Compulsory

Description: In the first half of the module, students are given an introduction to: the systems engineering process and how it can be applied to a variety of real world situations; the management skills necessary to facilitate the development of complex systems on time and within budget; how to recognise and manage risk and uncertainty. The key issues are examined for various strategies for implementation of sub-modules - analogue hardware, digital hardware, mechanical hardware, software. Limitations and imperfections of each approach, and sources of instability and catastrophic failure are considered. Method of design and modelling system elements and their interaction are considered.
In the second half of the module, students carry out a major group assignment that utilises the systems engineering approach to the design of a complete product.

Assessment: **50% EE2G1 Coursework**
50% EE2G2 Coursework

Objectives: On successful completion of this module, the student will be able to:
- Describe the key concepts of the systems engineering approach and understand how to function as project team members under modern project management techniques.
- Identify reasons for success or failure of systems engineering case studies
- Plan a project, with consideration of all aspects of the product life cycle
- Identify health and safety requirements and ethical and social issues related to engineering projects
- Evaluate the trade-offs between competing technologies for sub-system implementation
- Integrate software, electronic hardware and mechanical hardware into integrated systems and carry out and properly document an engineering project

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE 2EPR Electrical Power

10 Credits
Semester 1
Options 1

Description: Students will study in detail the way that electricity is generated and transported across country and how a national grid is operated. Issues of connection of local generation capability to a grid. Issues related to power quality and system stability. Three phase supply and provision of dual voltage supply systems. Simple transformer theory will be extended to consider street corner supply techniques. Battery storage in combination with solar panels for remote applications will be studied.

Assessment: **70% EE2EPR Exam**
2 hour exam in May/June, answer 3 questions from 4
30% Coursework

Objectives: By the end of the module the student should be able to:
- Demonstrate an awareness of the technical issues associated with providing electrical power on a national scale.

Pre-Requisites: **Co-Requisites:** **Prohib Combs**

Higher Level (Year 3)

BEng Elec and Elec Eng-LH

BEng

Choose 40 credits from section Options 1

Year Credits: 120
Total Credits: 360

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE3A1	0415652	Computer Hardware and Digital Design	10	1
EE3B1	0415653	Analogue Electronics	10	1
EE3C1	0422740	Power Electronics Applications	10	2
EE3G1	0401893	Organisation and Management	10	1
EE3P	0402279	Individual Project	40	1+2

Options 1

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE3A2	0422735	Computer Networking	10	2
EE3B2	0401839	Future and Emerging Device Technologies	10	2
EE3B3	0427422	Communication Electromagnetics	10	1
EE3C2	0402190	Control Systems Design	10	2
EE3D2	0422734	Advanced Communication Systems	10	2
EE3J2	0422739	Data Mining	10	2
EE3K1	0422736	Interactive 3D Simulation	10	1
EE3N1	0422737	Signal Analysis and Signal Processing	10	1
EE3N2	0415661	Digital Signal Processing	10	2
EE3T1	0421174	Electrical Power Transmission and Distribution	10	1
0427088	0427088	Atmospheric Engineering	10	2
MT 3ACE	0421171	Advanced Conventional Energy	10	2
MT 3REN	0422752	Renewable Energy	10	1
MOMD1 LH	Various	Module Outside the Main Discipline 1 LH	10	1or2
MOMD2 LH	Various	Module Outside the Main Discipline 2 LH	10	1or2

MEng Elec and Elec Eng-LH

MEng

Choose 50 credits from the section Options 1

Year Credits: 120
Total Credits: 480

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE3A1	0415652	Computer Hardware and Digital Design	10	1
EE3B1	0415653	Analogue Electronics	10	1
EE3C1	0422740	Power Electronics Applications	10	2
EE3G1	0401893	Organisation and Management	10	1
EE3GP	0401859	Group Design Project	30	1+2

Options 1

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE3A2	0422735	Computer Networking	10	2
EE3B2	0401839	Future and Emerging Device Technologies	10	2
EE3B3	0427422	Communication Electromagnetics	10	1
EE3C2	0402190	Control Systems Design	10	2
EE3D2	0422734	Advanced Communication Systems	10	2
EE3J2	0422739	Data Mining	10	2
EE3K1	0422736	Interactive 3D Simulation	10	1
EE3N1	0422737	Signal Analysis and Signal Processing	10	1
EE3N2	0415661	Digital Signal Processing	10	2
EE3T1	0421174	Electrical Power Transmission and Distribution	10	1
0427088	0427088	Atmospheric Engineering	10	2
MT 3ACE	0421171	Advanced Conventional Energy	10	2
MT 3REN	0422752	Renewable Energy	10	1
MOMD1 LH	Various	Module Outside the Main Discipline 1 LH	10	1or2
MOMD2 LH	Various	Module Outside the Main Discipline 2 LH	10	1or2

EE3A1 Computer Hardware and Digital Design

10 Credits
Semester 1
Compulsory

Description: Students deepen their knowledge of design methods digital systems and are introduced to Hardware Description Languages and automatic synthesis. Implementation styles (e.g. ASIC, FPGA) are introduced. The principle functional units of a modern computer system are designed. The principles of computer arithmetic and the IEEE 754 standard are introduced.

Assessment: **75% EE3A1 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
25% EE3A1 Coursework Assignment

Objectives: On completion of this module, students should be able to:
- Design, model and synthesise simple systems using VHDL
- Explain the key features of modern microprocessor design (e.g. superscalar, super-pipelining, out-of-order execution, VLIW, RISC versus CISC), and how they impact on processor performance
- Explain the architecture of a modern computer, identify issues affecting performance, and perform quantitative analyses on performance limits imposed by bus and memory hierarchy design
- Perform calculations on modern pipelined microprocessors in terms of instruction throughput
- Use testability enhancement techniques
- Generate test vectors, using Boolean differences and path sensitization methods.

Pre-Requisites: EE2A **Co-Requisites:** None **Prohib Combs** None

EE3A2 Computer Networking

10 Credits
Semester 2
Options 1

Description: Students are introduced to the major concepts of modern computer networks and the technologies underlying them. Network layer models, internet protocols and packet routing are studied. Fundamental concepts of cryptography and error control for secure and robust communication are also studied, along with more practical networking aspects, such as, network security and monitoring.

Assessment: **100% EE3A2 Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: On successful completion of this module, the student should be able to:
- Demonstrate an understanding of the computer networking fundamentals
- Analyse the operation of local area networks and in particular Ethernet networks
- Analyse the architecture, routing and addressing issues in IP networks and the Internet
- Have a qualitative understanding of the operation of transport layer protocols in TCP/IP
- Assess the problems associated with robust and secure communications across computer networks
- Perform calculations for selected error control and cryptographic algorithms
- Perform simple calculations characterising the operation of queuing systems

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE3B1 Analogue Electronics

10 Credits
Semester 1
Compulsory

Description: Power amplifier circuits are introduced. Class A, B and AB amplifiers are studied in detail along with the related issues of efficiency, power dissipation and heat sinking requirements. High frequency performance of transistors is studied. The resulting effects on the common-emitter amplifier and measures to counter them are explored. Sources of noise in electronic circuits are introduced. Concepts of noise figure, noise temperature and the design of low-noise amplifiers are studied. The design of active RC filters is introduced.

Assessment: **100% EE3B1 Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: On successful completion of this module, the student will be able to:
- Design and analyse class A, B and AB power amplifier circuits.
- Design and analyse common-emitter and cascode amplifiers in terms of their frequency response.
- Design low noise amplifiers and calculate the noise figure of a common-emitter amplifier.
- Design and analyse active RC filter circuits.

Pre-Requisites: EE2B **Co-Requisites:** None **Prohib Combs** None

EE3B2 Future and Emerging Device Technologies

10 Credits
Semester 2
Options 1

Description: Scaling of semiconductor devices is discussed with reference to Technology Roadmaps. The potential roadblocks to the future scaling of MOS transistors are outlined. Future and emerging devices such as single electron tunnelling transistors, intramolecular nanoelectronic devices, and carbon-based devices are described. Techniques for fabricating nanoelectronic circuits, including extreme UV and x-ray lithography are described. Future circuits and systems are introduced through the ‘System on a chip’ that integrates devices such as optical waveguides, modulators and detectors and molecular electronics. Carbon-based electronic technologies such as flat screen displays and organic computers are also covered. The module concludes with a look at the key technology drivers and markets.

Assessment: **100% EE3B2 Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: On successful completion of this module, the student will be able to:
- Calculate the current-voltage behaviour of short channel MOSFETs
- Calculate sub-threshold currents in MOSFETs
- Perform scaling calculations, and comment on their trustworthiness
- Calculate the limitations on devices imposed by fundamental physics
- Analyse a wide range of emerging device technologies in terms of their ability to supplant or augment present-day silicon technology for electronics application.

Pre-Requisites: EE2B **Co-Requisites:** None **Prohib Combs** None

EE3B3 Communication Electromagnetics

10 Credits
Semester 1
Options 1

Description: RF & Microwave Communicaton link components. An introduction to Noise temperature, noise factor and sources of noise. Discussion of microwave links based on Link budget.

Basic theory of antennas, their properties and behaviour. Microstrip antennas. Mobile phone antennas. Array antennas for smart/adaptive communications and radar. Plane wave propagation and polarisation. Interaction of plane waves with dielectric and metallic boundaries

Transmission Lines as an extension to normal wire conductors. Reasons for using transmission line techniques. Coaxial lines, microstrip lines, and their use in microwave circuits. Reflections, VSWR, reflection coefficient and matching.

Introduction to Electromagnetic Compatibility. Near field effects and interference. Screening/shielding. Radiated emission models. Capacitive/inductive coupling and crosstalk.

Microwave measurement systems and associated errors – lab demonstration. Introduction to Microwave CAD package for visualisation and self study.

Assessment: 70% by 1½ hour examination in May/June, answer 2 questions out of 3; 30% by coursework

Objectives: By the end of the module students should be able to:

- Demonstrate understanding of the basic properties of radiated electromagnetic waves and antennas.
- Manipulate the interactions of transmission line circuit components and antennas.
- Perform a detailed analysis and describe the measurement process of antennas and high frequency circuits used in communications systems.
- Demonstrate understanding of the basics of electromagnetic compatibility and interference, and provide solutions for screening and shielding.

Pre-Requisites: EE2B2 **Co-Requisites:** **Prohib Combs**

EE3C1 Power Electronics Applications

10 Credits
Semester 2
Compulsory

Description: An initial description of power electronic devices and the use of them as switches leads to their application in three-phase rectifiers and three-phase inverters. 3, 6 and 12 pulse rectifiers are examined, including full harmonic analysis of the waveforms and the calculation of power factor. Rectifier overlap and output voltage regulation are also analysed. Quasi-squarewave inverters are examined in detail and the principles of sinusoidal PWM are introduced. A section is devoted to the creation of rotating flux in AC machines; the steady-state equivalent circuit and characteristics of the induction motor, and AC variable speed drive systems. The final section covers filtering, high-power-factor rectification, power quality issues and legislation.

Assessment:
80% **EE3C1 Exam**
2 hour exam in May/June, answer 3 questions from 4
20% **EE3C1 Coursework**

Objectives: On successful completion of this module, the student will be able to:
- Perform design calculations and rate the devices for converters and inverters
- Identify the correct device for a particular application and provide adequate control signals to the devices.
- Calculate PF and basic circuit design for PF improvement.
- Design differential mode filters with damping.
- Design macroscopically an AC machine and evaluate steady-state performance

Pre-Requisites: EE2C1 **Co-Requisites:** None **Prohib Combs** None

EE3C2 Control Systems Design

10 Credits
Semester 2
Options 1

Description: This module introduces students to the methods for control system design for linear and time-invariant dynamics. Firstly, classical methods are presented for single input - single output (SISO) systems. Both analogue and digital controller designs are introduced based on frequency-response, prototype closed loop dynamics and pole-placement techniques. Then state-space based methods are introduced and applied to the design of state-feedback and state-feedback-observer controllers for multivariable systems based on pole-placement. Multivariable integral control links the classical design ideas and the state-space approach. This is followed by a number of specific design examples and exercises to develop students' design skills.

Assessment:
70% **EE3C2 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
30% **EE3C2 Coursework Assignment**

Objectives: On successful completion of this module, the student will be able to:
- Design a SISO analogue or digital controller that achieves the transient and steady-state specifications when applied to a plant that can be modelled as a liner dynamic system under additive disturbances;
- Design industrial PI and PID controllers and tune them according to the needs;
- Carry out multivariable control design applying state feedback-observer controller and develop the initial prototype;
- Apply feedback and compensation techniques in order to reduce the impact of disturbances on existing controller performance.

Pre-Requisites: EE2C2 **Co-Requisites:** None **Prohib Combs** None

EE3D2 Advanced Communication Systems

10 Credits
Semester 2
Options 1

Description: The module develops students' understanding of digital communication systems, including base band signals, methods of modulation/demodulation and analysis of wireless systems.

Assessment: **100% EE3D2 Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: On completing the course, students should be able to:
- Describe digital base-band and pass-band signals and modulation - demodulation methods and technique
- Understand the basic principles behind communications, and specifically wireless systems
- Analyse the major parameters and architectures of modern communication systems

Pre-Requisites: EE2D1 and EE2D2 **Co-Requisites:** None **Prohib Combs** None

EE3J2 Data Mining

10 Credits
Semester 2
Options 1

Description: Data mining is concerned with computational techniques for data analysis, to extract relevant information or discover underlying structure. The data is high dimensional and too vast for manual analysis. The first part of the course concentrates on text and presents the principles which underpin current text search engines. The second part is concerned with generic techniques for analysing and discovering the underlying structure of general abstract data sets.

Assessment: **100% EE3J2 Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: On completion of this module, students should be able to:
- Construct a basic text-based search engine, including:
  - Text normalization: stop-word removal, stemming
  - Implementation of a Document Index
  - Calculation of Term-Frequency, Inverse Document Frequency similarity between queries and documents
- Understand the basic principle of Latent Semantic Analysis
- Understand the use of synonyms, hyponyms and hypernyms in information retrieval
- Understand the goals of data mining
- Implement maximum likelihood estimation of Gaussian PDF and Gaussian Mixture PDF parameters for a given data set
- Understand the basic principle of Principle Components Analysis
- Understand and apply agglomerative, divisive and k-means clustering algorithms
- Understand and apply sequence matching techniques based on dynamic programming
- Understand the basic principles of Artificial Neural Networks

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE3K1 Interactive 3D Simulation

10 Credits
Semester 1
Options 1

Description: This module provides a framework for the development of interactive systems and key human-centred design issues with regard to their use and application. Students will acquire the skills necessary to develop interactive 3D games, including 3D modelling and integration with an appropriate, professional real-time engine. The module also addresses interactive technologies and human factors issues associated with VR, Synthetic and Games-Based Environments.

Assessment:

5% EE3K1 Workplan Presentation

35% EE3K1 Group Report

60% EE3K1 Group Presentation

Objectives: On successful completion of this module, the student should be able to:

- Understand the pitfalls of "technology push" when considering the application of novel interface devices to real-life applications
- Create an interactive 3D scenario using an appropriate 3D modelling toolkit and games engine.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE3N1 Signal Analysis and Signal Processing

10 Credits
Semester 1
Options 1

Description: Students are introduced to spectral analysis, convolution, time-invariant and distortionless systems, and matched filtering including chirp filters.

Assessment:

100% EE3N1 Exam

2 hour exam in May/June, answer 3 questions from 4

Objectives: On completion of this module, students should be able to:

- Describe continuous signals as time waveforms or frequency spectra
- Transform signals from one representation to another
- Know and use the Fourier transform theorems
- Apply spectrum analysis, convolution and correlation processes
- Find the power spectra of random signals
- Describe the behaviour of linear time invariant systems
- Understand the nature of a distortionless system
- Understand the features of matched filtering
- Perform calculations on chirp signals and filters

Pre-Requisites: EE2D1 & EE2D2 **Co-Requisites:** None **Prohib Combs** None

EE3N2 Digital Signal Processing

10 Credits
Semester 2
Options 1

Description: Engineering application of discrete Fourier transform , FFT, z-transform, FIR and IIR digital filters are introduced to students. The application examples are reinforced by problem solving classes.

Assessment: **100% EE3N2 Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: On successful completion of the module, students will be able to:
- Explain and quantify the application of both discrete Fourier transform and z transform
- Design digital FIR and IIR filters.
- Critically appraise the relative merits of LC, IIR and FIR filters for diverse applications.

Pre-Requisites: EE2D1 & EE3N1 **Co-Requisites:** None **Prohib Combs** None

EE3T1 Electrical Power Transmission and Distribution

10 Credits
Semester 1
Options 1

Description: Students will build on their existing knowledge of single phase and three phase systems, transformers, switching devices and transmission lines, to develop an understanding of the issues behind power transmission & distribution grids. Lectures on the principles and main issues will be backed up by laboratory exercise involving simulations and case studies.

Assessment: **70% EE3T1 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
30% EE3T1 Coursework

Objectives: On completion of this module, students should be able to:
- Introduce the structure of electrical power transmission & distribution systems
- Calculate power flows and voltage profiles of electrical power transmission & distribution systems
- Explain the techniques for operation and control of electrical power transmission & distribution systems
- Explain the design and control of network systems to maintain statutory voltage and levels and frequencies.
- Analyse power transmission & distribution systems using analytical methods and computational tools.
- Perform calculations on fault levels and fault protection systems.
- Understand the techniques for market operations of electrical power transmission & distribution systems including load forecasting, demand management, power generation dispatching and ancillary services for electrical power transmission security.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE3GP Group Design Project

30 Credits
Semester 1+2
Compulsory
(MEng only)

Description: A technical specification is issued to groups of students. These groups then decide on their technical and managerial approach to the task. The groups are assessed on technical merit, added-value, end-product and demonstrable group working skills developed during the project.

Assessment:

5%	**First Demonstration**
5%	**Interim Group Report**
20%	**Second Demonstration**
67.5%	**Final Group Report**
2.5%	**Poster Session**

Objectives: On completion of this module, students should be able to:

- Study a problem independently and as a group
- Work as a productive member of a team
- Gather, organise and distil information from various sources, summarise the information succinctly, and draw general conclusions;
- Exercise initiative and independence in the planning and execution of a project, and manage time and resources competently
- Design a solution to an engineering problem, which will include one or more of the following:
    - Construction and testing of hardware or software solutions
    - Simulation/modelling and testing
    - Analysis and inference
- Critically appraise results, and present the essential features and conclusions clearly and coherently in both written and oral forms.

An excellent student will additionally be able to

- Design an innovative solution, informed by the forefront of knowledge, to a new engineering problem

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE3P Individual Project

40 Credits
Semester 1+2
Compulsory
(BEng only)

Description: Students negotiate a project title and specification with their supervisor. After an initial period of background work, they carry out the necessary design and practical work to complete their project

Assessment:

9.5%	**First Bench Inspection**
0.5%	**Second Stage Project Specification**
19%	**Second Bench Inspection**
70%	**Final Report**
1%	**Poster Presentation**

Objectives: On completion of this module, students should be able to:

- Study a problem independently
- Gather, organise and distil information from various sources, summarise the information succinctly, and draw general conclusions;
- Exercise initiative and independence in the planning and execution of a project, and manage time and resources competently
- Design a solution to an engineering problem, which will include one or more of the following:
    - Construction and testing of hardware or software solutions
    - Simulation/modelling and testing
    - Analysis and inference
- Critically appraise results, and present the essential features and conclusions clearly and coherently in both written and oral forms.

An excellent student will additionally be able to

- Design an innovative solution, informed by the forefront of knowledge, to a new engineering problem

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

Masters Level (Year 4)

MEng Elec and Elec Eng-LM

MEng

Choose 30 credits from the section Options 1

Year Credits: 120
Total Credits: 480

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE4F	0420583	Electrical Energy Conversion Systems	10	1
EE4G	0406217	Digital Design	10	1
EE4Z		Small Embedded Systems	10	2
EE4P	0406223	Individual Project	60	1+2

Options 1

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE4B	0424082	Communications Signal Processing	10	1
EE4D	0424083	Electromagnetics, Antennas and Propagation	20	2
EE4H	0406218	Computer Vision	10	2
EE4K	0421898	Intelligent Systems	10	2
EE4L	0422750	Computer and Communication Networks	10	2
EE4N	0424097	Satellite, Mobile and Optical Communications	20	2
EE4R	0406224	Spoken Language Processing	10	2
EE4T1	0424095	RF and Microwave Principles	10	1
EE4T2	0422751	RF & Microwave Engineering	10	2
EE4U	0426702	Human Factors and Interactive System Design	20	1
MOMD1 LM	Various	Module Outside the Main Discipline 1 LM	10	1or2
MOMD2 LM	Various	Module Outside the Main Discipline 2 LM	10	1or2

EE4B Communications Signal Processing

10 Credits
Semester 1
Options 1

Description: The module provides an introduction to random signals analysis and its role in communications signal processing, and digital communication systems optimisation. The module then analyses the process involved in digital communications, mobile communications channels and the relevant signal processing techniques. The particular emphasis is on the signal processing of GSM and CDMA communications that is the key technology behind 3G systems.

Assessment: **100% EE4B Exam**

Objectives: By the end of the module students should be able to:

- apply statistical signal processing methods and classical statistical theory to communication system analysis;
- analyse a communication system performance for a given system configuration and parameters;
- synthesise the structure and parameters of a communication system for a specified performance.

Pre-Requisites: EE3D2 **Co-Requisites:** **Prohib Combs**

EE4D Electromagnetics, Antennas and Propagation

20 Credits
Semester 2
Options 1

Description:

The aims of this course are to:
Review mathematical and statistical techniques that support the theory of electromagnetics and propagation studied in the remainder of the module.
Make students aware of analytical methods for the solution of electromagnetics problems.
Give students an understanding and awareness of computer aided design in electromagnetics.
Describe the fundamental principles of a number of components where electromagnetic analysis is required.
Understand the basic principles of antenna operation, analysis and design.
Understand the physics of radiowave propagation at a number of frequency bands and environment

Students taking this module must have an understanding of basic electromagnetism (the magnetic field of a solenoid and wire, Lenz's Law etc), differential and integral calculus.

Assessment: **100% EE4D Exam**

Objectives:

By the end of the module students should be able to:
- Solve problems using special functions, partial differential equations, and vector calculus using analytical and numerical techniques.
- Choose suitable electromagnetic based tools for the analysis of components.
- Use electromagnetic CAD tools.
- Demonstrate an understanding of the basic principles behind electromagnetic analysis.
- Describe the operation of and perform design calculations on selected electromagnetic systems.
- Analyse simple antennas and quantify their properties.
- Perform simple path loss calculations for a range of radiowave propagation problems.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE4F Electrical Energy Conversion Systems

10 Credits
Semester 1
Compulsory

Description: Electrical energy systems integration is discussed. A detailed description of power electronic converters and inverters will be given. This will include a treatment of PWM strategies for converters and invertors, including diode and controlled converters. Interfacing devices to complex systems will be discussed with reference to hybrid vehicles and renewable energy generation. An overview of emerging energy devices will be given and will include; fuel cells, battery systems, super-capacitors, flywheels and magnetic storage.

Assessment: **100% EE4F Exam**
2 hour exam in May/June, answer 3 questions from 4

Objectives: After completing this module, students should be able to:
- Sketch waveforms for and explain the operation of combinations of six-pulse converters, including overlap and load regulation in twelve-pulse converters and control of circulating current in back-to-back converters.
- Describe the principles of pulse-width modulation using a generic strategy based on volt-second equivalents, calculate depth of modulation and minimum pulse widths, undertake complex Fourier analysis of waveforms.
- Explain the application of PWM techniques in inverters and reversible converters
- Explain the operation of energy devices including analysing the performance characteristics
- Perform system design and integration of hybrid devices
- Explain and analyse the methods used for renewable energy grid connection

Pre-Requisites: EE3C1 **Co-Requisites:** **Prohib Combs**

EE4G Digital Design

10 Credits
Semester 1
Compulsory

Description: This module builds on the material of EE3A1 to deepen students' knowledge and understanding of the design of large-scale digital projects using VHDL for FPGA and ASIC implementation. The hierarchy of design abstraction and the process of top down design are overviewed. Advanced concepts and methods of VHDL are surveyed. The process of synthesis is introduced, and the synthesisable subset of VHDL is considered. FPGA architectures are investigated, and the required tools for partition, placement and routing are examined. Issues involved in FPGA based implementations of advanced digital designs are illustrated by practical laboratories and an assignment.

Assessment: **100% Coursework Assignment**

Objectives: On completing the course, students should be able to:
- Perform designs of complex logic systems using VHDL
- Produce synthesisable VHDL for the custom digital circuitry of an embedded system
- Produce designs with testability enhancement
- Design fast arithmetic circuits

Pre-Requisites: EE3A1 **Co-Requisites:** **Prohib Combs**

EE4H Computer Vision

10 Credits
Semester 2
Options 1

Description: This module is designed to provide an introduction to the theory and application of key issues in image interpretation.
Students will learn about methods for enhancing and interpreting both still and video images, methods of evaluation and tools for building image interpretation programmes
Students will be required to analyse selected research.

Assessment:

33.33% EE4H Demonstration 1

33.33% EE4H Demonstration 2

33.33% EE4H Assignment

Objectives: On completing the course, students should:

- Analyse academic papers on computer vision.
- Apply and implement image enhancement algorithm.
- Apply and implement binary and grey-level mathematical morphology algorithms.
- Implement algorithms for identifying the boundary of objects in an image.
- Apply motion estimation algoriths.
- Develop model-based image interpretation strategies
- Solve practical image interpretation problems

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE4K Intelligent Systems

10 Credits
Semester 2
Options 1

Description: Modelling of nonlinear and uncertain systems by using fuzzy, neural and fuzzy-neural approximators are examined and applications of these approximators to the synthesis of learning control algorithms are presented. Approaches to intelligent control system design are presented. An emphasis is placed on efficient integration of qualitative and quantitative knowledge in order to handle uncertainty and complexity of system dynamics. The design approaches and solutions are illustrated by a number of real life applications. A MATLAB-SIMULINK based assignment gives practice in selecting and using these techniques.

Assessment:

65% EE4K Exam

2 hour exam in May/June, answer 3 questions from 4

35% Coursework Assignment

Objectives: After completion of this module, students should be able to:

- Model nonlinear systems based on data records by using static and dynamic neural networks,
- Integrate qualitative knowledge expressed in the form of heuristic rules and quantitative knowledge to design models of nonlinear systems by using fuzzy-neural networks,
- Design learning neural and fuzzy controllers for uncertain plants,
- Design a fast prototyping fuzzy PI controller for a nonlinear and uncertain SISO plant,
- Design a multiregional controller for a nonlinear plant,
- Overcome the drawbacks of a classic controller operating at a specific site by introducing a supervisory controller based on existing operational experience at a plant site,
- Synthesise on-line identification algorithms with neural and fuzzy aproximators based on real time data structured over moving measurement window.

Pre-Requisites: EE2D1 and EE2C2 **Co-Requisites:** **Prohib Combs**

EE4L Computer and Communication Networks

10 Credits
Semester 2
Options 1

Description: This module will begin by reviewing basic notions of layerd architectures in data networks. A brief introduction to queuing theory will also be given. This will be followed by lectures on a small number (2-3 typically) of advanced networking topics from an extensive list that includes: Wireless networks, sensor networks, multicasting, QoS and queuing, network overlays, VoIP and real-time transport protocols, network security, network measurements and the large-scale structure of the Internet, etc.

Assessment:

90% EE4L Exam

10% EE4L Presentation

Objectives:

- Demonstrate knowledge of distributed systems principles and algorithms pertinent to networks.
- Critically assess the merits and drawbacks of state of the art networking technologies and proposals for future systems.
- Perform basic calculations to calculate metrics commonly used to characterise networks and be able to interpret the results.
- Be able to perform reasoned critiques of state of the art research publications in the field of networks.

Pre-Requisites: EE3A2 **Co-Requisites:** **Prohib Combs**

EE4N Satellite, Mobile and Optical Communications

20 Credits
Semester 2
Options 1

Description: The aims of this course are:

To introduce and overview the wide range of current personal and mobile, satellite and optical communication systems.
To describe the propagation environment involved in such systems and to explain methods of characterisation.
To explain typical modulation, coding and multiplexing methods.
To describe the system and network aspects of typical mobile systems.
To introduce optical fibres, laser diodes and Photo-detectors.
To discuss in detail: optical transmitters; optical receivers; and optical fibre communication systems in particular coherent fibre communications and wavelength division multiplexing systems

Assessment: **100% EE4N Exam**

Objectives: By the end of the module students should be able to:

- Discuss the design and configuration of satellite and mobile communication systems to meet specific requirements.
- Discuss appropriate measures to overcome the problems caused by different propagation environments.
- Calculate figures of merit for basestations, earth stations, satellite transponders and mobile units and use these in assessing link budgets.
- Perform quantitative design on optical fibre systems.
- Describe roles of optical transmitter, fibre and receiver in an optical fibre communication system.
- Design both conventional and coherent optical fibre communication systems.
- Critically appraise the relative merits of satellite, cellular and optical fibre communication systems for diverse applications.
- Calculate figures of merit for basestations, earth stations, satellite transponders and mobile units and use these in assessing link budgets.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE4R Spoken Language Processing

10 Credits
Semester 2
Options 1

Description: The aim of the module is to provide an understanding of the scope, principles, capabilities and applications of speech and language processing.
Students will learn about basic principles of human speech production and perception and methods for processing of speech signals. Students will learn in-depth about automatic speech recognition, in particular, the employment of hidden Markov models for modelling of time-varying signals, such as speech, principles of language modelling and strategies for dealing with noise.

Assessment:
90% EE4R Exam
10% Coursework Assignment

Objectives: On successful completion of this module the student will
- Demonstrate an appreciation of the full range of spoken language technologies.
- Explain the basic principles of human speech production and perception and use the language of elementary phonetics.
- Demonstrate an understanding of the different modelling assumptions which are used in speech recognition and language processing and an awareness of their strengths and weaknesses in the context of spoken language processing.
- Demonstrate an in-depth understanding of automatic speech recognition using Hidden Markov models, principles of language modelling and strategies for dealing with noise.
- Apply their understanding of the capabilities of spoken language processing systems and trade-off different capabilities in order to meet application requirements.
- Demonstrate an understanding of the multimodal aspect of spoken language.
- Explain the range of potential applications of spoken language processing.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE4T1 RF and Microwave Principles

10 Credits
Semester 1
Options 1

Description: The module covers the principles of RF and microwave engineering that underpin the design of analogue front end elements of communication systems. Computer simulation of passive and linear active microwave circuits is also introduced through laboratory sessions.

Assessment:
75% EE4T1 Exam
25% Coursework Assignment

Objectives: On completing the module, students should be able to:
- interpret the scattering parameters of microwave and RF components;
- explain the operation of and carry out first order design calculations on some passive and linear active components, such as transmission lines, filters, couplers and amplifiers;
- use a representative commercial microwave circuit simulation tool to simulate some basic microwave components and be aware of the limitations

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE4T2 RF & Microwave Engineering

10 Credits
Semester 2
Options 1

Description: Methods of analysing both active and passive circuits will be developed, based on s-parameters and ABCD parameters. CAD techniques for RF and microwave circuits will be introduced and the capabilities and characteristics of field solvers and circuit simulators will be studied. Linear, non linear and noisy circuits will be analysed using circuit simulation CAD. CAD based tuners and optimisers will be introduced and their advantages and disadvantages will be discussed.

Assessment: **100% EE4T2 Exam**

Objectives: By the end of the module students should be able to:

- Explain the operation of a wide range of active and passive RF and microwave components, including advanced filters, linear and non-linear amplifiers, mixers, modulators and control components
- Apply appropriate methods to the analysis or synthesis of some representative components
- Summarise the advantages and disadvantages of different analysis and synthesis tools

Pre-Requisites: None **Co-Requisites:** EE4T1 **Prohib Combs** None

EE4U Human Factors and Interactive System Design

20 Credits
Semester 1
Options 1

Description: Aims:
To provide an overview of fundamental principles and practices of human-centred design of interactive systems;
To explain the theoretical principles of human-computer interaction;
To analyse the basic physiological, psychological and social factors that influence human-computer interaction;
Graphical design for interaction;
Usability evaluation and analysis

Assessment: 100% coursework

Objectives: By the end of the module students should be able to:

- Describe and assess the range of human factors issues central to the design and development, selection and evaluation of interactive technologies and computer interfaces
- Qualitatively evaluate the importance of human factors approaches and techniques at different stages of interactive system and product life cycles (Human Factors Integration)
- Describe and assess the basic cognitive factors and interaction design issues that influence human-computer interaction and interactive systems design
- Apply basic Human Factors principles of human-computer interaction to the design of user interfaces and interactive technologies
- Evaluate and redesign a user interface
- Critically evaluate two or three contemporary commercial-off-the-shelf interactive technologies identified from online sources
- Undertake basic task analysis exercises and assess key human-centred design issues such as human performance (strengths and limitations), mental workload assessment, situational awareness, error analysis, cognitive walkthrough, etc.

Pre-Requisites: None **Co-Requisites:** None **Prohib Combs** None

EE4Z Small Embedded Systems

10 Credits
Semester 2
Compulsory

Description:

The aims of this course are to:

Introduce the theory and practical skills relating to embedded systems design construction for industrial applications, including real time control and embedded networking.

Introduce students to a range of embedded systems application domains.

Review basic concepts in digital and analogue circuit design, and programming as required by different microcontrollers and microprocessors (including C, Java, Python).

Introduce students to the key design criteria and programming design tools useful to embedded systems design through a selection of devices (e.g., PIC micro-controllers, Arduino, Rapsberry Pi).

Make students aware of an array of communications buses and peripheral devices that can be used as part of an embedded system.

Assessment:

A written unseen examination of 2 hours answering 3 questions from 4.

Objectives:

By the end of the module students should be able to:

- Design and develop small embedded system
- Design small embedded systems in industrial applications
- Design embedded systems that use standard communication buses to interface to peripheral devices

Pre-Requisites: **Co-Requisites:** **Prohib Combs**

EE4P Individual Project

60 Credits
Semester 1+2
Compulsory

Description: Students negotiate a project title and specification with their supervisor. After an initial period of background work, they carry out the necessary design and practical work to complete their project.

Assessment:

100%	**Ind Project**
5%	**EE4P First Report**
5%	**EE4P Technical Presentation**
5%	**EE4P Second Report**
14%	**EE4P Bench Inspection**
70%	**EE4P Final Report**
1%	**EE4P Poster Presentation**

Objectives: On completion of this module, students should be able to:

- Study a problem independently
- Gather, organise and distil information from various sources, summarise the information succinctly, and draw general conclusions from fragmentary or conflicting data;
- Demonstrate awareness of new and emerging technologies
- Exercise initiative and independence in the planning and execution of a project, and manage time and resources competently
- Design an innovative solution, informed by the forefront of knowledge, to a new engineering problem, which will include one or more of the following:
- Construction and testing of hardware or software solutions
- Simulation/modelling and testing
- Analysis and inference
- Critically appraise results, and present the essential features and conclusions clearly and coherently in both written and oral forms.
- Evaluate the limitations of a solution, suggest how it might be improved, and under what circumstances it is likely to fail.

Pre-Requisites: **Co-Requisites:** **Prohib Combs**