Electrical and Railway 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 Electrical + Railway Eng

BEng

All modules are compulsory

Year Credits: 120
Total Credits: 360

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
CE 1IRE	0426930	Introduction to Railway Engineering	20	1+2

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

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

CE 1IRE Introduction to Railway Engineering

20 Credits
Semester 1+2
Compulsory

Description: This module introduces students to the unique features of Railway Engineering, placing them in a context of history, sustainable development and environmental impact. The module will consist of a number of topics providing links to future modules in the Railway Engineering minor programme.

Assessment: 100% coursework

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

- Demonstrate a broad awareness of the development of rail transport technology;
- Demonstrate an awareness of the issues affecting sustainable development of rail transport and its impact on energy use and the environment;
- Demonstrate knowledge about the broad underpinning technologies of modern rail systems;
- Utilise and apply this knowledge and awareness to practical railway design problems.

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

Intermediate Level (Year 2)

BEng Electrical + Railway Eng

BEng

All modules are compulsory

Year Credits: 120
Total Credits: 360

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE2A	0419504	Digital Systems and Embedded Computing	20	1+2
EE2B2	0421173	Electromagnetics	10	2
EE2C	0419506	Electrical Energy Systems and Control	20	1+2
EE2D1	0417024	Fundamentals of Signals and Systems	10	1
EE2G	0424091	Project Management and Professional Practice	20	1+2
CE 2RIF	0426931	Railway Infrastructure Engineering	20	1+2
CE 2RTR	0426933	Railway Traction	20	1+2

Progress Requirements

In order to proceed to BEng 3 students are required to have:
a) attempted all pre-requisite modules (i.e. EE2B2 and EE2C);
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

EE2B2 Electromagnetics

10 Credits
Semester 2
Compulsory

Description: 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% **EE2B2 Exam**
1.5 hour exam in May/June, answer 2 questions from 3
15% **EE2B2 Assessed Laboratories**

Objectives:
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

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

CE 2RIF Railway Infrastructure Engineering

20 Credits
Semester 1+2
Compulsory

Description: Students will learn about the fundamental structural components of the railway track and how they are designed to withstand the effects of train and environmental forces so that the railway foundation is adequately protected and train / track operating costs, passenger comfort and safety are kept within acceptable limits. To this end the module will consist of topics related to the track structure as a whole and its components parts including the rails, fastenings, sleepers, ballast, the formation and subsoil. Switches and crossings and the overhead line electrification system will also be covered. Aspects of concreted (slab track) will also be addressed. Consideration will also be given to appropriate track maintenance.

Assessment: 70% examination, 30% coursework

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

- Demonstrate knowledge of the major components of the conventional and ballasted track systems;
- Demonstrate an understanding of the purpose and properties of individual track components;
- Demonstrate an understanding of the way in which track components degrade over time;
- Demonstrate an understanding of the way in which the components of railway track are combined to form a structural system which can withstand the combined effects of traffic and the environment;
- Demonstrate knowledge of slab track systems;
- Demonstrate knowledge about track maintenance technologies of modern rail systems;
- Utilise and apply the knowledge, awareness and understanding of track components to develop the structural design of a conventional ballasted railway track.

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

CE 2RTR Railway Traction

20 Credits
Semester 1+2
Compulsory

Description: This module introduces students to components and systems used for diesel-powered and electrically-powered railway traction . It will cover all aspects of railway traction, including both AC and DC electrification systems, together with an analysis of the different options which are available for traction packages. These will include both AC and DC traction drives, and treatment of the operation of the necessary power electronic converters which are required to modulate the power received from the primary source.

Assessment: 70% examination, 30% team exercise

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

- Demonstrate a broad awareness of the operations of railway traction systems;
- Demonstrate an awareness of the impact of traction drives on energy use of trains;
- Demonstrate knowledge about the future trends of railway traction systems;
- Utilise and apply this knowledge and awareness to practical railway design problems.

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

Higher Level (Year 3)

BEng Electrical + Railway Eng

BEng

All modules are compulsory

Year Credits: 120
Total Credits: 360

Compulsory

Dept Code	***Banner***	***Module Title***	***Credits***	***Semester***
EE3C1	0422740	Power Electronics Applications	10	2
EE3C2	0402190	Control Systems Design	10	2
EE3G1	0401893	Organisation and Management	10	1
EE3T1	0421174	Electrical Power Transmission and Distribution	10	1
EE3P	0402279	Individual Project	40	1+2
EE 3ROM	0426935	Railway Operations and Management	20	1+2
EE 3TCO	0426936	Train Control	20	1+2

MEng Electrical + Railway Eng

BEng

Choose 10 credits from optional modules to be confirmed

Year Credits: 120
Total Credits: 480

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE3C1	0422740	Power Electronics Applications	10	2
EE3C2	0402190	Control Systems Design	10	2
EE3G1	0401893	Organisation and Management	10	1
EE3T1	0421174	Electrical Power Transmission and Distribution	10	1
EE3GP	0401859	Group Design Project	30	1+2
EE 3ROM	0426935	Railway Operations and Management	20	1+2
EE 3TCO	0426936	Train Control	20	1+2

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
Compulsory

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

EE3T1 Electrical Power Transmission and Distribution

10 Credits
Semester 1
Compulsory

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

EE 3RO Railway Operations and Management

20 Credits
Semester 1+2
Compulsory

Description: This is an advanced module that provides core competencies in railway operations and management, including the principles and practice of timetabling, allocation and disposition of assets and people, underlying economic considerations and high level operating principles.

Assessment: 50% Exam, 50% Coursework

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

- Understand and synthesise the key concepts of railway operations;
- Appreciate and apply common, as well as advanced methods, for railway timetable construction;
- Demonstrate an ability to use macro and micro simulation tools to evaluate timetables;
- Comprehend and use underlying economic methods.

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

EE 3TCO Train Control

20 Credits
Semester 1+2
Compulsory

Description: This is an advanced module that provides core competencies in railway signalling, train control, traffic management and communications principles and practice.

Assessment: 50% Exam, 50% Coursework

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

- Understand and synthesise the key concepts of railway signalling, train control and vital and non-vital communication systems;
- Appreciate and apply advanced methods for railway traffic management, including simulation and optimisation;
- Demonstrate an ability to use railway traffic management macro and micro simulation tools;
- Comprehend and interpret the results of real-world scenarios.

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

Masters Level (Year 4)

MEng Electrical + Railway Eng

BEng

All modules are compulsory

Year Credits: 120
Total Credits: 480

Compulsory

Dept Code	*Banner*	*Module Title*	*Credits*	*Semester*
EE4F	0420583	Electrical Energy Conversion Systems	10	1
EE4K	0421898	Intelligent Systems	10	2
EE4P	0406223	Individual Project	60	1+2
0426938	0426938	Advanced Topics in Railway Engineering	40	1+2

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**

EE4K Intelligent Systems

10 Credits
Semester 2
Compulsory

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**

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**

Advanced Topics in Railway Engineering

40 Credits
Semester 1+2
Compulsory

Description:

Description This module is compulsory for students on the MEng Civil and Railway Engineering, and the MEng Electrical and Railway Engineering Students will attend a series of “master classes” given primarily by rail industry speakers, covering a wide range of railway engineering topics. These lectures will be delivered as part of the suite of Railway engineering Masters programmes, and will be grouped into 8 one day (5 to 6 hours) classes. Each group of lectures will also be the subject of a one hour seminar for students on the MEng Civil and Railway Engineering, and the MEng Electrical and Railway Engineering. These lectures and seminars will provide the basic material for the module assessment – a detailed consideration of two current railway industry projects, considering particularly system aspects and presented in two 5000 word essays.

Assessment: 100% coursework

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

- Demonstrate a broad awareness of a range of advanced topics within the railway industry in the UK and elsewhere;
- Demonstrate an in depth understanding of the interaction of different railway sub-systems in the context of ongoing major projects;
- Demonstrate critical judgement in evaluating current and proposed technological methods for railway construction and operation.

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