Objectives

After completing this module, students will:

- Be capable of analysing simple problems arising in science and engineering for the purpose of programming with a computer.
- Be capable of using MATLAB in an interactive mode - entering and assigning data to variables and using plotting functions.
- Be capable of writing simple programs using, as and when necessary, loop structures and conditional statements including 'for loops', 'while loops' and 'if-then-else' constructs and user-defined functions.
- Be able to design and/or analyse engineering systems using state-of-the-art CAD tools relevant to their chosen discipline; either SIMULINK, the Communications Toolbox, OrCAD PSpice or SolidWorks

Overview

Initially all students will be introduced to MATLAB as both an interactive medium, a data analysis tool and as a program development environment. The cohort will then be split according to their degree disciplines and be introduced to either Simulink, the Communications toolbox, PSpice or SolidWorks as appropriate.

The introduction to MATLAB will include the following topics:

- Scalar variables: assignment of values; scalar arithmetical operators + - */^ two
- Arrays (of numbers) : array operations .* and ./
- Loops: typical ‘for’ and ‘while’ loops
- Branching statements: ‘if-then-else’ and ‘switch’
- In-built functions: sine, cosine, tangent, sqrt, logarithm …
- User-defined functions
- Plotting commands

The other CAD topics will be introduced during the module.

Assessment

Individual examination of MATLAB by 2 hr practical examination (70%) and coursework assignment for the CAD tools (30%).

E. Prempain
EG 7013 Modelling and Classification of Data

Objectives

The overall objective is to reveal the wide range of methods available to extract information from experimental data. In particular the course aims to familiarise students with statistical, deterministic and chaotic models of data generation and to consider statistical, fuzzy and neural network schemes of pattern recognition. At the end of the course the students should be able to appreciate the rich variety of existing techniques, to be familiar with the literature and to be able to follow research papers in selected areas. The course is ideal for research training and for understanding state-of-the-art current practice.

Overview

Subjects studied will be selected from the following list of topics:

- Data generation models; stochastic, deterministic (chaotic)
- Data classification methods; statistical pattern recognition, fuzzy methods, neural networks
- Information theory, probability, and entropy
- Neural Networks
- Statistical pattern recognition
- Fuzzy logic methods

Assessment

Formal two-hour written examination (70%) and one computer-based test in the areas of probability, statistics, statistical models and/or neural networks (30%).

Recommended Reading

Bishop, C.M., Neural Networks for Pattern Recognition, OUP, 1995.

R. Morales
Objectives

By the end of the module, students are able to do the following:

- Design hardware and software for single-processor embedded systems
- Understand a typical embedded systems development cycle
- Design real-time embedded systems using the C programming language following specific coding guidelines
- Understand the differences among different scheduling approaches and paradigms
- Understand the need for timing analysis in real-time embedded systems
- Use the C programming language to create hierarchical system designs
- Be familiar with different types of task scheduling and have a general understanding of their strengths and weaknesses
- Use the C programming language and time-triggered scheduling paradigms to develop their own embedded system demonstrator

Overview

This module is concerned with the design and implementation of software and hardware for embedded systems based on a single processor. The key focus of the module is on the production of applications that are modular and highly reliable; based on time-triggered system architectures.

Course Format

In keeping with its advanced nature, this course takes the form of:

- A series of lectures focusing on the hardware and software design aspects of embedded systems, with particular attention paid to reliability and code reuse.
- A set of guided design exercises, involving the creation of small embedded applications.

Assessment

The course will be examined on the basis of coursework exercises (100%).

Recommended Reading


I. Kyriakopoulos
Objectives

At the end of this course students should be able to:

- discuss the basic principles of robust control and be familiar with the classical approach to robust control based on loop shaping and the Nyquist stability criterion;
- discuss the factors that affect the stability and performance of linear feedback control systems in real world operation environment (dynamic perturbations, disturbances, etc.);
- understand the extension of the classical approach to multivariable robust control which makes use of H-infinity methods and robust stabilisation;
- design robust controllers based on classical loop shaping (frequency domain designs, singular value plots, gain and time delay margins); and formulate a robust controller design framework and use H-infinity methods for robust controller design (state-space controller synthesis approaches).

Overview

This course is concerned with the design of practical feedback controllers. Feedback is used in a control system to stabilise an unstable plant/process and to reduce the sensitivity of the system to signal uncertainty (disturbances and noise) and model uncertainty (dynamic perturbations). If the performance specifications are achieved in the presence of the expected uncertainties, then the control is said to be robust. The course will re-examine the classical approach to robust control based on loop shaping and the Nyquist stability criterion; it will present the latest (H-infinity) methods and tools for loop-shaping control and robust stabilisation; and it will describe the inherent limitations to performance. The treatment will be mainly for scalar (single-input, single-output) systems but the extension to multivariable (multi-input, multi-output) systems will also be discussed. Extensive use will be made of Matlab.

Assessment

The course will be assessed by means of a formal written examination (70%) and a design assignment (robust controller design case study, 30%).

Recommended Reading

R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley.
D.-W. Gu, P.Hr. Petkov and M.M. Konstantinov, "Robust Control Design with Matlab", Springer.

R. Morales
EG 7016 Design of Discrete Systems

Overview

This module will provide an understanding of the background theory associated with discrete system analysis followed by a review of design methods associated with the main classes of discrete systems. There will be a structured series of lectures and exercise classes. The course will start with a review of the fundamental principles of data conversion and the background theory of discrete signals and systems. Familiarity with continuous linear system theory and complex algebra will be assumed. Students will acquire a working knowledge of discrete system analysis and design techniques and will be able to read and understand the extensive literature in this field. At the end of this module students should be able to:

- Read and demonstrate understanding of the established literature in the field of discrete-time signal processing.
- Analyse and predict the response of known linear time-invariant discrete systems.
- Design linear time-invariant FIR and IIR filters from either time or frequency domain representations.
- Obtain and interpret the spectra of discrete-time signals.
- Design appropriate schemes for the spectral analysis of discrete-time signals.

Contents

The following topics will be covered:

- Discrete-time signals and systems
- Data conversion
- Discrete-time signals
- Linear time-invariant (LTI) systems
- Difference equations and convolution sums.
- Frequency-domain representation of discrete-time signals and systems
- The z-transform
- Pole-zero representation of discrete-time systems
- Transfer function of discrete-time systems
- Sampling of continuous-time signals
- Reconstruction of a band-limited signal from its samples
- Discrete-time processing of continuous-time signals
- Representation and analysis of LTI systems using the Fourier and z transforms
- Filter design techniques
- The discrete Fourier transform
- Case studies and examples

Assessment

The module will be assessed by means of an examination (100%).

Recommended Reading


F.S. Schlindwein
EG 7017 Real-Time Signal Processing

Objectives

The objective of this course is to give students a deep understanding of the practical issues of real-time digital signal processing.

Background

The background assumed is familiarity with the fundamentals of Digital Signal Processing and general ideas of programming. No prior knowledge of DSP chips or Assembly is assumed.

Course Format

The course will be organised around a set of laboratory sessions using a modern DSP chip and a PC and analysing real signals in real-time. The sessions will exploit some of the following central themes:

- Sampling: Interrupt based A/D sampling; programming the sampling frequency; control of A/D and D/A; effects of finite word length.
- Real-time implementation of FIR filters: Finding the coefficients and implementing low-pass, high-pass, band-pass, and band-reject FIR filters.
- Real-time implementation of IIR filters: A simple extension of the fundamental implementation covered on the previous session.
- Real-time implementation of FFTs: Exploiting a given algorithm and measuring its performance.

At the end of the course the students should be very familiar with the practical implementation of real-time systems and be able to implement them starting from the specified difference equation. The course is ideal for research students and engineers who will deal with both real-time and off-line implementations of digital filter and/or the implementation of control systems.

Assessment

50% Continuous Assessment (lab report, design exercise, essays), and 50% Individual examination.

Co-requisite

EG 7016 Design of Discrete Systems

Recommended Reading

Ifeachor Jervis, "Digital Signal Processing, a practical approach", Addison Wesley, 1993

F.S. Schlindwein
Objectives

By the end of the module, students are able to do the following:

- Understand the importance of reliability in embedded systems developments
- Design and apply several mechanisms and techniques which can improve the reliability of an embedded system
- Understand the importance of testing and of correct timing behaviour in the development of a reliable embedded system
- Be able to apply a range of measurement-based techniques to test several aspects of the reliability of an embedded system

Overview

This module is concerned with the design and implementation of mechanisms which can improve the reliability of an embedded system as well as with the use of testing techniques in these systems.

Course Format

In keeping with its advanced nature, this course takes the form of:

- A series of discussions about particular systems;
- A set of guided design exercises, involving the creation of small embedded applications.

Assessment

The course will be examined on the basis of submitted project and essay work (100%).

Pre-requisite

EG 7014 – High-Reliability Embedded Systems.

Recommended Reading


I. Kyriakopoulos
EG 7020 Individual Project

Objectives

This module gives an opportunity for individual study and for the development of personal and technical skills. The Individual Project enables the student to integrate the knowledge obtained throughout the MSc course in a realistic exercise in the practice of engineering at a professional level. At the end of the module, students will also have acquired communication skills, both oral and written.

Overview

The Individual Project is a major part of the MSc course and will occupy approximately one third of the student's time. The project is an organised activity that aims to deliver an example of professional engineering work. At the beginning of the project, the objectives of the project will be defined, followed by an assessment and implementation of the means of achieving the objectives, and concluded by clear communication, both written and oral, of the results. The core of the project, the practical activity directly concerned with achieving the objectives, depends on the nature of each project and the project supervisor is the main reference point for this.

The project may be initiated by the student or selected from a list of topics offered by academic staff. The project can be theoretical, experimental, analytical or design and often consists of an investigation into a problem of current industrial interest or the development of either a piece of equipment or a design aid. Many projects are related to sponsoring companies or to the research interests of the supervisor.

Assessment

This module is 100% continuously assessed

Recommended Reading

Kirkman, J., Good style for scientific and engineering writing, Pitman, 1980.
Ellis, R., Hopkins, K., How to succeed in written work and study, Collins, 1985. 

R. Morales
EG 7021 Radio Systems

Objectives

At the end of the course students should have a broad appreciation of a wide range of radio system applications and have developed a basic understanding of their modes of operation, the equipment requirements and limitations and the radio propagation mechanisms. They should also have developed an in-depth understanding of the operation of several of the systems discussed in the course.

Overview

A range of radio system applications will be examined in this course, concentrating on the areas of communications, radar, remote sensing and navigation. International regulation of radio spectrum usage will also be considered.

A wide range of topics will be included to give a broad appreciation of the applications of radio systems. Several topics will be covered in depth, examining both the propagation mechanisms and the system techniques. Specifically, the following areas will be addressed:

- Communications: Personal communications, broadcast systems, point-to-point and network systems channel evaluation, frequency management, equalisation, security;
- Target location: Line of sight radar, over the horizon (OTH) radar, direction finding, stealthing;
- Remote sensing: Satellite-to-ground radar, meteorological radar, ionosondes (vertical and oblique);
- Navigation: Global positioning system (GPS), phase interference systems (e.g. Omega);
- Regulation: International Telecommunications Union (ITU) and national legislation.

Course Format

The course material will be delivered through lectures, class discussions, and computer-based laboratory exercises.

Assessment

Assessment will be by marks awarded for laboratory work (30%) and end-of-module examination (70%).

Recommended Reading

A list of recommended textbooks and references will be provided during the module.

A.J. Stocker
EG 7022 Digital Communications

Objectives

This module addresses many of the topics that need to be considered in the design of digital communications systems. At the end of the module students should have developed a broad understanding of digital communication systems together with an appreciation of the limitations of these systems and the techniques employed to mitigate the limitations.

Overview

The module will be delivered through a series of seminars and practical sessions. The theoretical aspects of the module will be complemented with extensive practical exercises using MATLAB based computer modelling.

Subjects which will be studied include:

- Introduction to MATLAB and the Communications Toolbox;
- Baseband digital transmission;
- Digital transmission through bandlimited channels;
- Digital transmission via carrier modulation;
- Channel capacity and coding;
- Digital communications through fading multipath channels.

Assessment

Assessment will be by marks awarded for laboratory work (30%), individual project (30%) and by a written examination (40%).

Recommended Reading

Öberg, T., Modulation, Detection and Coding, Wiley (2001)
Bateman, A., Digital Communications, Addison-Wesley (1998)

D. Siddle
Objectives

At the end of the module students should have developed a broad understanding of the requirements for the planning and operation of a number of radio communication systems together with an appreciation of the limitations of these systems. A deeper understanding of several of the topics discussed during the module will also have been gained.

Overview

In this module some of the points which should be considered in the design of modern operational radio communication systems will be addressed. In particular, service planning and propagation prediction tools will be introduced for a number of systems and at a range of different radio frequencies. Some of the topics on radio communications which were presented in the module ‘Radio Systems’ will be examined in more depth.

The module will be delivered through a series of lectures, seminars and practical sessions. The theoretical aspects of the module will be complemented with extensive practical exercises using both state-of-the-art modelling packages and prediction tools, and data taken ‘off-air’.

Subjects which will be studied include:

Propagation:
- Radio channel characteristics: For example, the effect of the ionosphere on HF communication systems;
- Simulation: By understanding the physical mechanisms which affect radio propagation enables their effects can be simulated;
- Predictions: The ability to predict the behaviour of radio systems is crucial to the design of communication systems.

Systems:
- Point-to-point and network: For example, indoor wireless networking;
- Mobile and personal: The now ubiquitous mobile phone is a good example;
- Broadcasting: Even in the age of the internet, radio (and television) broadcasting continues to be of importance.

Assessment

Assessment will be by marks awarded for laboratory work (30%), individual project (30%) and by a written examination (40%).

Pre-requisite:

None

Recommended Reading

Davies, K., Ionospheric Radio, Peter Peregrinus, (1990)
Agrawal, D.P. and Zeng, Q-A Introduction to Wireless and Mobile Systems, Cengage (2016)

D. Siddle
EG 7026 Advanced Fluid Dynamics

Objectives

Students will be exposed to a range of contemporary developments in fluid dynamics. This exposure will include research activities in theoretical, computational and experimental fluid dynamics.

Overview


Recommended Reading


Assessment

This module will be assessed on the basis of a formal written examination (100%).

S. Gao
EG 7028 Understanding Surfaces in Engineering

Aims

To gain practical experience of the way in which surface engineered components respond to mechanical contact; to study methods to characterise the mechanical properties of surface engineered components.

Objectives

- To teach the experimental techniques relevant to determining the mechanical properties of surfaces. This will be specifically targeted at developing experimental test methodologies and good experimental practice relevant to an engineer.
- To develop an understanding of the important factors in processing experimental results and data and develop an understanding of the implications of the results with particular relevance to surface engineering and optimising properties such as wear resistance.

Overview

Mechanical properties of surfaces (24 hours)

Assessment

Coursework (10%), Lab Report (20%) Examination (70%)

D. Weston
Objectives

By the end of this module, students will have gained the following skills:

- Select an appropriate numerical modelling strategy to capture the defining flow features of typical geometries (e.g. sudden expansions, jet flows, compressor blade passages).
- Recognise the relevant strengths and weaknesses of commonly used turbulence models and numerical schemes for given flow problems.
- Appreciate the effects of grid resolution and computational domain constraints on the quality of Computational Fluid Dynamics (CFD) predictions.

Overview

The course starts with an overview of the flow governing equations applicable to incompressible and compressible flows, which are solved in a computational fluid dynamics scheme. This forms a firm basis from which to address current numerical techniques and turbulence modelling.

The focus of the course then turns to numerical simulation methods that are widely used in both academia and in industry. Widely used turbulence modelling methods are discussed and their relative strengths and weaknesses for differing flow types are outlined. Unsteady methods are also covered, with emphasis placed on sub-grid scale modelling and grid resolution requirements. Numerical stability and discretization issues are outlined for common schemes. The solution procedures for compressible and incompressible CFD codes are discussed along with the practical limitations of both types of methodologies.

All of these elements are brought together in case studies of typical CFD cases, such as mixing layers, compressor blade passages, and backward-facing steps. The module lectures are supported through the Blackboard virtual learning environment. Example sheet questions are provided at appropriate intervals during the course.

Course format

- A series of lectures on CFD models and methods.

Assessment

The course will be examined by a formal written examination (100%).

Pre-requisite

EG 7026 - Advanced Fluid Dynamics

Recommended books


A. Rona
Aims
The aim of this course is to introduce the students to the theoretical and practical aspects of the mechanics of composite materials.

Objectives
The objectives of this course are:
- to develop a fundamental understanding of the mechanics of fibre-reinforced and particulate reinforced composites
- to develop a fundamental understanding of the theory of anisotropic elasticity, upper and lower bounds of effective properties such as extensional and flexural stiffness, plate and shell theory for laminate structures
- to develop a fundamental understanding of failure mechanisms and failure criteria, and the consequences of impact damage on performance.
- to appreciate how to analyse and design composite structures, how to develop computational models of composite structures
- to understand the typical application areas for different types of composite.

Overview
Composite materials are constructed from two different materials with significantly different physical properties. Laminate composites, such as carbon fibre reinforced polymer (CFRP), are typically designed to produce structural components with very high strength to weight ratios. Hence they are commonly used in aircraft components, boat hulls, racing car shells and bicycle frames. The recent Boeing 787 airliner is the first aircraft to have its wings and fuselage constructed from CFRP. Particulate composites typically have a metal or ceramic matrix containing ceramic particles or whiskers. These are used for engine components, disk brakes and heat shields amongst other applications.

Composite materials behave differently than homogenous materials. It is therefore important to understand how they carry and distribute loads, and therefore determine if and when they will fail.

Assessment
The assessment will consist of a 2.5-hour examination
Objectives

This course teaches the design, construction and operation of electrical machines and drives including many of the detailed aspects of operation which are neglected in BEng undergraduate courses. Students will be able to make more detailed calculations and predictions of the operation of machines under dynamic conditions and when connected to electronic drives.

Overview

Introduction  Definition of machine and drive. Revision of mechanical principles. Mechanical loads and their characteristics.

The basics of electromagnetic torque production for singly and doubly excited systems.

Application of matrix methods to electrical networks, Voltage equation, Impedance matrix, Linear transformations in electric circuit analysis.

Choice of transformation - Invariance of power, symmetrical components. Application to single phase transformer.


Linear transformations, 3-phase to 2-phase, 2-phase to stationary axes, Brush shift.

The form of the transient impedance matrix, Fundamental torque equations.

Summary. Overview of Machine Analysis.

Application to DC and other commutator machines, separately excited, compound and series connections.

Inter-connected DC machines. Motor and generator, metadyne transformer.

Analysis of two pole synchronous machine with salient poles. Reduction to primitive machine, impedance and torque equations. Excitation and reluctance torque.

Poly-phase induction machines. Reduction to primitive machine, impedance and torque equations.

Reading Assignment 2.


Incorporation of saturation, slip dependence of rotor parameters, eddy current loss, phase sequence reversal and incorporation of mechanical system models.


Switched Reluctance Motors, operation, design, construction, analysis. Stator and rotor pole numbers and relationship to number of phase windings. Power electronic control.

Assessment

Formal written examination (100%).

Recommended Reading

J.Hindmarsh, Electrical machines and drives systems, Butterworth-Heinemann, 1996

P. W. Lefley
Objectives

This course provides a theoretical and practical treatment of the complete electronic drive system; (including conventional dc drives as well as modern ac drives) including the mechanical part, the electrical machine, the power converter and the control. It will provide the necessary skills for those students wishing to pursue a career in industrial drives. This course consists of lectures, continually assessed projects and CAD simulations.

Overview

PART A – High Power Circuits
The application of thyristors and GTOs in three phase ac regulators, phase controlled rectifiers, line commutated inverters and pwm inverters. Appropriate analysis for phase angle control, pwm pattern generation for harmonic minimization. The dc link converter, current and voltage-fed types, bi-directional power flow. Use of modern devices, IGBTs and MOSFETs.

PART B – Electric Motor Drives
To study the application of high power semiconductors to the control of electrical machines. Speed and torque control of dc and ac motors. Stator and rotor control of induction motors. Generation and braking. Flux vector control. Control of dc machines, brushless dc motors, stepper motors and switched reluctance motors. Design of low cost electronically controlled drives for high volume manufacture.

Assessment

Formal written examination (100%).

Pre-requisite

EG 7034 Electrical Machines and Drives

Recommended Reading

Lander, C.W., Power Electronics, McGraw-Hill 1993
Module aim and learning outcomes

Background: In industry, commercial software is used to carry out finite element analysis in structure design. An engineer is often shielded from the details of the numerical method, but an engineer has to understand the underlying principle of the method in order to use it correctly. Furthermore, an engineer has to be able to select the correct material model, set the right boundary conditions, and choose the appropriate finite element for the analysis. This module prepares students for using modern commercial finite element packages. The module will help you to develop an in-depth understanding in the general structure behind computational stress analysis and, in particular, the various constitutive laws that you have to select for various design problems. It also provides you with the practical experience of finite element analysis by going through a series of exercises in the computer lab.

Learning outcomes: This module provides the students with an advanced theoretical grounding as well as hands-on experience in modern finite element analysis for structure analysis. At the end of this module, students should be able to

a) understand the underlying principles of the finite element method
b) use the finite element method for stress analysis in practical engineering design.
c) choose correct constitutive laws and failure theory in the finite element analysis.
d) apply finite element analysis in realistic and sophisticated engineering structures

Lectures cover
a) Variational principles and finite element method
b) Constitutive laws for engineering materials including plasticity theory
c) Failure theories for engineering materials
d) Use of finite element analysis in engineering design

Practice sessions cover finite element analysis of
a) Long/short beams, plastic beams and limit loads
b) Stress concentration and plasticity
c) Use of sub-models for global and local analysis
d) Creep and stress relaxation

Teaching and learning method
Lectures (one hour per week) and supervised practical exercises (2 hours per week) using a commercial finite element package.

Methods of assessment
Written exam covering both the theoretical and practical parts of the module (2.5 hours)

Jingzhe Pan
EG 7038 Aerospace Materials

Development of new materials and enhanced materials properties are at the forefront of the enormous improvement in the performance, reliability and sustainability of advanced aerospace systems. The performance requirements of air and spacecraft place huge demands on their materials of construction. Graduates with sound knowledge of the attributes of different classes of materials will be at the forefront of these developments. In addition to the traditional aerospace sector, other industries are increasingly adopting materials with aerospace heritage, e.g. automotive, motorsport, marine and renewable energy. The Aerospace Materials module will provide a sound foundation for a wide variety of careers and give you an appreciation of how material properties contribute to the performance of advanced engineering systems. The module provides an opportunity to study a comprehensive range of topics in structural materials, informed by the latest research and industrial practice.

This module is taught by Dr Hugo Williams and covers a number of major material groups or topics:

- ‘Light’ alloys based on aluminium, titanium and more exotic metals such as magnesium and beryllium
- Nickel-based superalloys; used for high temperature applications in gas turbine engines
- Polymer composite materials such as carbon fibre reinforced plastic
- Sandwich materials
- ‘Smart’ or ‘multifunctional’ materials and structures

Teaching sessions are based on conventional lectures but incorporate active learning tasks and some group work. Additional resources, links to appropriate online learning tools and example problems are placed on Blackboard.

Recommended Reading:

The following are ‘traditional’ reading list of books. No one book covers all the material. You would not be expected to cover the material in all of these books. Other resources (e.g. journal papers, design handbooks, videos etc.) will be made available via Blackboard as appropriate.

- Roger C. Reed, the Superalloys, Cambridge, 2006
- Ian Polmear, Light Alloys: from traditional alloys to nanocrystals, 2005

H.R. Williams
Objectives

At the end of this module students should:

- be able to analyse an engineering process to determine if linear theory is adequate for controller development or if nonlinear tools are more appropriate
- understand the limitations of linear control methods
- be able to demonstrate the application of nonlinear analysis techniques
- identify and analyse appropriate nonlinear control strategies
- be able to demonstrate knowledge of the likely robustness of the proposed solution

Overview

This module will describe advanced procedures for the design of nonlinear controllers for nonlinear systems. There will be a structured series of lectures, laboratory and exercise classes followed by a design study. As in the previous related modules, the software package Matlab and its accompanying tool-boxes will be used extensively.

The following topics will be covered:

Development of tools for nonlinear system analysis including:
- the design of feedback linearising controllers
- describing function analysis
- an introduction to passivity theory

Nonlinear control system design methods including:
- the design and inherent advantages of variable structure control systems
- sliding mode control theory and an assessment of its inherent robustness properties
- constructive Lyapunov design methods

Case studies will include the development of nonlinear controllers for a two link robot manipulator and various electric motors.

Recommended Reading


M. Turner
Objectives
To apply the fundamental concepts of Newtonian mechanics in order to gain a sound understanding of the dynamics of mechanical systems. To introduce a broad range of analytical tools with which to analyse, model and design complex mechanical systems. At the end of the course students should be able to understand how to apply analytical tools and methods to mechanical systems from a broad range of application domains: e.g. robotics, aircraft/spacecraft/vehicles dynamics, etc.

Overview
Subjects studied will be selected from the following list of topics:

- Kinetics of rigid bodies in planar motion
- Kinematics of rigid bodies in three dimensions
- Kinetics of rigid bodies in three dimensions
- Euler's equations of motion for a rigid body
- Vibrations of two degree-of-freedom systems
- Lagrangian equations

Recommended Reading

E. Prempain
Objectives

By the end of this module, typical students will be able to:

- Give a system level analysis of a complex aerospace product, such as an aircraft engine.
- Discuss current trends in the design and production of an aircraft engine.
- Discuss some of the wider business aspects of aerospace manufacturing, such as globalization, outsourcing, and sustainability.
- Identify new processes and innovation opportunities relevant to aircraft engines and evaluate their Technology Readiness Level.

Overview

This module is based on a series of lectures delivered by Rolls Royce design engineers, from the aerospace engine division. Students get a first-hand insight of the aircraft engine design process, from concept, through detailed design, manufacturing, and life-long support. Specific lectures on manufacturing, control, aerodynamics, heat management, fan blade testing, and component life monitoring cover the state of art and give future perspectives in these areas. Students conduct further independent learning on these topics by directed reading from a reading list and from complementary information sources.

Reading List


The industrial lecturers will typically use copyright material from their company in the lectures. These cannot be made available electronically on Blackboard to students. Therefore, students are encouraged to take a full set of notes during all lectures.

The industrial lecturers expect students to use their presentations as a prompt to conduct further independent reading, using the reading list provided, to develop the students’ subject specific knowledge. This reading of engineering is required in preparation to the exam. Students are referred to the reading material published on the Blackboard website of this module, in particular to the revision guidance.

A. Rona
Systems engineering is essentially a group of tools and techniques developed to make engineering products work as required, despite being composed of many interacting elements. Organisations such as the Royal Academy of Engineering and numerous engineering employers have identified that this group of skills are, and will increasingly become, critical to the success of all engineering endeavours. Knowledge of the principles of the discipline and how to apply some of the key techniques are an important professional asset for engineering and science graduates. Systems engineering as a discipline originally evolved to enable large aerospace projects, and so it is a natural fit to consider the key sub-systems of spacecraft in parallel with an understanding of the systems engineering fundamentals. The principles of systems engineering can and should be applied to the development of any engineering system. The spacecraft systems part of the module is intended to give a solid grounding in the main design/operational challenges and solutions used in space vehicles. Such systems are technical achievements that have brought enormous economic and social benefits to mankind and have allowed us an insight into the most fundamental questions about our Universe.

This course will be taught by Dr Hugo Williams and Dr Nigel Bannister and provides an opportunity to study a module informed by the space projects currently being undertaken in the Space Research Centre.

The Systems Engineering part of the module will introduce the following topics: system lifecycle, requirements, trade-offs, types of modelling, mass and power budgetting, safety and reliability, quality and product assurance, cost, risk, human factors.

The Spacecraft Systems part of the module will introduce: orbits, propulsion, launch vehicles, space environment, data, telemetry and command, attitude & orbit control, power, spacecraft materials and structures, spacecraft thermal engineering and atmospheric (re-)entry.

Teaching sessions are based on conventional lectures but incorporate active learning tasks and some group work. Additional resources, links to appropriate online learning tools and example problems are placed on Blackboard.

Reading List

- Peter Fortescue et al. Spacecraft Systems Engineering. 2\textsuperscript{nd} Ed. 1995, 3\textsuperscript{rd} Ed. 2003. 4\textsuperscript{th} Ed. 2011.
- James Wertz et al. Space mission analysis and design, 1999; Space mission engineering 2011.