ELECTRONIC AND ELECTRICAL ENGINEERING MSc

Block taught, individual modules are also highly suitable as CPD for professional engineers needing to fill a skills gap.

Compulsory Modules

- ASIC Engineering
- Sensors and Actuators for Control
- Embedded Software Development – new for 2014
- Individual Project

Optional Modules (Choose five)

- Communication Networks
- Fundamentals of Digital Signal Processing
- Solar Power 1
- Water Power
- Communications Channels
- DSP for Software Radio
- Innovation
- Mobile Networks
- Holistic Engineering
- Advanced FPGAs – new for 2014
- Engineering Applications - new for 2014

The following descriptions of modules are intended as a guide to the curriculum. The content may be subject to change at the discretion of the University.

COMPULSORY MODULES

ELP405 Application Specific Integrated Circuit (ASIC) Engineering

The aim of the module is to teach students tools and methodologies for designing complex Application Specific Integrated Circuits (ASICs), using VHDL for design entry and the CADENCE software for synthesis and back-end design. A second aim is to help students understand the various levels of abstraction in ASIC design and to appreciate the complexity of designing state-of-the-art VLSI chips.

It includes the following topics:

- Introduction to the Linux OS.
- Introduction to IC design and to Cadence CAD tools.
- Combinational and Sequential Logic.
- Logic styles. Adders, shifters, multipliers.
- Architectural level.
- Concept of a high level language.
- RTL formulation.
- The data-path.
• FSM.
• Behavioural, structural and data-path modelling and simulation.
• VHDL - Types; Signals and variables; concurrent and sequential statements; entities and architectures; components and configurations; processes, procedures and functions; packages; blocks; aliases.
• Binding, elaboration and simulation.
• Use of the Leapfrog simulation package.
• Logic synthesis algorithms.
• Synthesising combinational and sequential circuits.
• Synthesising systems.
• Cadence RTL Compiler: Advanced synthesis techniques.
• Layout Issues. Placement, routing and floor-planning. Use of the Place and Route package Silicon Ensemble.
• Issues in Clock design. Skew, delay, clock distribution.

Dr Vassilios Chouliaras

ELP022 Embedded Software Development
The aim of this module is to help students understand the need for a systematic approach to embedded software development and to gain experience of such an approach in a practical setting.

It includes the following topics:
• Need for embedded software development. Systematic approaches to software development. Software quality and development processes. Coding standards and software lifecycle.
• Languages for embedded systems and software test
• Basic features of real-time operating systems and practical aspects of real-time operating systems

Dr David Mulvaney

ELP068 Sensors and Actuators for Control
The aims of this module are for the students to understand the options available and the issues related to selection of sensors and actuators for control systems.

It includes the following topics:
• Sensors: Sensed quantities; Sensor types and principles; Uses of Sensors; Dynamics of Sensors; Sensor systems; smart sensors; Sensor fault detection and redundancy.
• Actuation: Basic principles; Hydraulic systems; Pneumatic systems; Electrical systems; Advanced materials; Choice of actuation system; Open and closed loop actuator; Actuator Fault Tolerance and redundancy.
• System design of sensor/actuator systems and control systems.

Dr Roger Dixon

ELP020 Project
The aims of this module are to give postgraduate students the experience of a substantial, individual research project in areas covered by one of the MSc programmes from the School of Electronic and Electrical Engineering and to do this in a manner which illustrates insight into, and training of, appropriate research methods.

The project is conducted under the supervision of a member of the School’s academic staff in a research area appropriate to your MSc programme.

Dr Rob Seager
OPTIONAL MODULES (choose 5)

**ELP009 Communication Networks**
This module covers the main principles of communication networks and includes the following topics:

- Introduction to network topology and architecture.
- The Physical Layer.
- The Datalink Layer; protocols and frame structures.
- The Network Layer.
- Routing.
- Local area networks, Ethernet, WLAN.
- The Transport Layer; addressing, buffering.
- Servers; Bridges, routers, gateways.
- The IP Protocol; Addressing, UDP, TCP/IP.
- Delay analysis. Queuing analysis.

Dr Alex Gong

**ELP006 Fundamentals of DSP**
This module covers the fundamentals of information theory and its applications to source coding and channel coding.

It includes the following topics:

Measure of information, self-information, mutual information, entropy, Shannon's source coding theorem, variable length codewords, craft inequality, Huffman coding, speech coding, image coding, video coding, transform coding, discrete cosine transform, channel capacity, Shannon's channel coding theorem, MIMO capacity, linear block codes, cyclic codes and convolutional codes

Professor Sangarapillai Lambothoran

**ELP033 Solar Power 1**
This module covers the facts governing the nature, availability and characteristics of the solar resource at chosen sites and the fundamental concepts of photovoltaics and thermal conversion. The conversion technologies are examined critically in terms of design, efficiency, manufacturing options and costs.

It includes the following topics:

- Solar energy resource
- Solar thermal systems
- Principles of solid state physics of PV cells
- PV systems
- Interfacing technology
- Manufacturing processes.

Dr Gianfranco Claudio

**ELP035 Water Power**
This module introduces the laws governing the availability of hydro power in its conventional form as well as in the form of wave and tidal power. The fundamental concepts of water turbines, wave energy devices and tidal power schemes are also considered.

It includes the following topics:

- Review of resource
- Hydrodynamics
- Water turbine types
• Conventional hydropower including micro-hydro
• Wave energy and proposed conversion technologies
• Tidal power
• Air turbines
• Scaling
• Economics.

Professor Simon Watson

ELP069  Innovation
The aim of this module is for the students to understand the relationship between creative management, innovation and enterprise. By preparing a business plan the students will gain a competency that can make a direct contribution to UK plc.
It includes the following topics:
• Creative management: ideawriting, nominal group technique and interpretive structural modelling.
• Business and Financial Planning: risk management, reasons for success and failure of companies.
• Intellectual Property: an awareness of the breadth of methods available together with an appreciation of the issue of whether to protect or to license business ideas.
• Innovation: concepts, methods and models of idea generation and capture.

Professor Ron Summers

ELP015  Communications Channels
In telecommunications and computer networking, a communication channel is the transmission medium conveying the signal and can be physical, such as a wire, or wireless, such as a radio channel.
This module includes the following topics:
• The free space channel - Friis equations, antennas, receivers and receiver noise and CNR calculation.
• Fading in terrestrial and satellite links - weather and ionospheric effects and Rayleigh and Mie fading.
• Satellite links including cross links.
• Optical links and their specific problems.
• Methods of countering channel imperfections - diversity techniques, equalisers.
• Introduction to antenna and transmission lines.

Professor Yiannis Vardaxoglou FREng

ELP071  Holistic Engineering
The aim of this module is for students to understand the range of challenges thrown up by complex engineering projects and the techniques that can be applied to overcome them. Whilst the nature of the role of engineering has evolved markedly over recent decades, it is the ability to take that role's holistic perspective that the module aims to develop in the student.
A range of case studies from the military aircraft domain provides the focus of the module, but the content, the systems approaches taken and the learning achieved are sufficiently transferable to other engineering domains and industrial sectors for any student to benefit from taking this module.

The module will push the boundaries of multi-disciplinary engineering through a mixture of practical experiences on hugely demanding programmes, and an exploration of the current state of theory as it applies to such programmes. The case studies from real programmes will be used to illuminate a range of critical topics including requirements definition, problem analysis, system architecture, the product lifecycle, engineering organisation design etc., which will then be subject to rigorous exploration in the theory and practical sessions.
It includes the following:
Experience from five multi-national military aircraft programme case studies will be used to explore typical challenges posed by complexity in the problem domain, the solution domain, the commercial and business environment and the extended engineering enterprise within it.

The systems perspective, holistic in its approach to solution lifecycle, the role of products, their missions and functions, the role of services, the contextual impact of solutions, their environmental impact and stakeholder interest management, will provide a framework for understanding the means to achieve multi-disciplinary engineering solutions to physical engineering problems.

The learning from the five case studies will motivate, evidence and support the systems perspective and the engineering techniques within it. The students will practise the skill of developing an Engineering Management Plan to tackle a hypothetical case study outwith the military aircraft domain.

**ELP008 Digital Signal Processing for Software Defined Radio**

This module is an introduction to software defined radio, in particular key digital signal processing operations with moderns. It includes the following topics:

- Review of Fourier analysis and linear time-invariant systems.
- Digital transmission systems. Sampling and discrete time systems.
- Multirate signal processing.
- Random processes and adaptive filtering: Least Mean Square (LMS) and Recursive Least Squares (RLS), and applications in channel equalization and synchronization.

**Professor Sangarapillai Lambothoran**

**ELP017 Mobile Network Technologies**

This module covers the practicalities of mobile telecommunication systems, their constraints and ways that these constraints may be countered. It includes the following topics:

- 1 x CDMA2000, EDGE, GPRS, GSM, HSDPA, UMTS
- Basic System Design
- Network Planning.
- Network Operation
- Cellular Systems
- Multiple Access Techniques
- Spectrum, LTE, WiMAX.

**Dr Rob Edwards**

**ELP021 Advanced FPGAs**

Students will learn to specify the architecture and then design and implement systems on programmable chips (SoPC) using established and advanced methodologies. Topics include –

- FPGA Review and FPGA internals.
- Advanced VHDL for System FPGAs
- System-on-Programmable-Chip architectures using Xilinx XPS/Vivado/Altera QSYS
- Advanced Concepts: Multiple clock domains, retiming, pipelining, interfaces (Ethernet, DDR). Full system simulation
- Behavioural synthesis: Use of C2H and AutoESL tools
- Lab project: Application of all principles taught in the teaching lab, targeting real FPGA silicon

**Dr Vassilios Chouliaras**
ELP025 Engineering Applications
This module looks at the collection and processing of realtime signals from the ultrasonics and biomedical fields. These signals are very often low level and noisy and the module will provide examples of how such problems are overcome. Topics covered include -

- Transducers: Sensor types and principles; Sensors and systems;
- Sensor drivers: Passive sensor readout circuit
- Connecting sensors to microcontrollers (systems)
- Connecting smart sensors to PC/Network
- Sensor systems for biomedical monitoring.
- System design of sensor circuits for engineering applications.

Dr Paul Lepper and Dr Sijung Hu

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For further information about the School of Electronic, Electrical and Systems Engineering, please see our website at www.lboro.ac.uk/ese