UNIVERSITY OF LEADING THE WAY WESTMINSTER

PROGRAMME SPECIFICATION

Course record information

Name and level of final award:	MSc Electronics with Robotic and Control Systems MSc Electronics with Embedded Systems MSc Electronics with System-on-Chip Technologies MSc Electronics with Medical Instrumentation The above awards are Bologna FQ-EHEA second cycle degree or diploma compatible.
Name and level of intermediate awards:	Postgraduate Diploma Electronics Postgraduate Certificate Electronics
Awarding body/institution:	University of Westminster
Teaching Institution:	University of Westminster
Status of awarding body/institution:	Recognised Body
Location of delivery:	Cavendish
Language of delivery and assessment:	English
Mode, length of study and normal starting month:	Full-Time; Part-Time (Two-year); Part-Time (Three-year)
QAA subject benchmarking group(s):	Electronic Engineering Computer Science
Professional statutory or regulatory body:	IET
Date of course validation/review:	2015
Date of programme specification approval:	2015
Course Leader:	
Course URL: Westminster Course Code: JACS code: UKPASS code:	westminster.ac.uk/courses/postgraduate H610

Admissions requirements
There are standard minimum entry requirements for all undergraduate courses. Students are advised to check the standard requirements for the most up-to-date information.

For most courses a decision will be made on the basis of your application form alone. However, for some courses the selection process may include an interview to demonstrate your strengths in addition to any formal entry requirements.

More information can be found here: westminster.ac.uk/courses/postgraduate/how-to-apply

Aims of the Course
The overall aim of the electronic suite of MSc courses is to provide an enriching learning experience, enhancing the knowledge and skill base of the participating students in the area of modern electronic systems design. In particular the courses will develop advanced practical skills to enable the student to determine system requirements, select and deploy a suitable design process and use the latest specialist tool chains to test and/or prototype a device or algorithm. Modern electronic systems today are a combination of software and hardware solutions that require engineers with cross discipline skills to implement them. The courses in the electronic suit cover a broad range of disciplines that will enable a successful graduate to enter into a career that requires a cross disciplined approach and a practical hardware and software skillset. The courses are intended both for engineers in current practice and for fresh honours graduates to facilitate their professional development, mobility and employability.

More specifically, the generic aims of the courses are to:

- G1. Encourage a lively investigative spirit that will sustain a commitment to independent future study.
- G2. Provide communication skills associated with oral and written presentations of technical work and develop interpersonal and organisational skills associated with project planning, execution and appraisal.
- G3. Provide individualised experience of a significant individual project which exploits and applies disparate modules of knowledge.
- G4. Foster a spirit of independent student-centred study with effective management of time and development of research methods.
- G5. Provide a broad coverage of engineering topics that includes not only technical design issues but also a wider set of considerations including social and economic issues, ethical issues and environmental issues.
- G6. Develop team work skills by providing a frame work of team activities

MSc Electronics with Robotic and Control Systems
In addition, the MSc in Electronics with Robotic and Control Systems aims to produce postgraduates with a strong practical skill base that will enable them to model, analyse, design and prototype smart robotic sub-systems. Specialist knowledge and practical skillsets will be taught, extensively developed and practiced in the areas of control systems and the analysis, categorisation and design of robotic systems that facilitate movement with multiple degrees of freedom.

The knowledge and skillsets taught within the course are extensively used in the design of smart robotic devices used in industry such as assembly line robots. They are also the key enabling skillsets used to implement devices for applications such as security drones, warehouse robots, medical robots and more humanoid like robots. In addition smart instrumentation will be explored such as machine vision systems both in terms of the

algorithms used and the interfaces and hardware required.
Broader considerations such as the social and economic impact of robot devices, ethical and roboethics issues, health and safety and existing and forthcoming legislative issues will be examined. It is intended that the course will re-focus and enhance existing knowledge in the areas of software engineering, electronic engineering and real-time embedded systems to enable the student to participate in the fast expanding and exciting sector of industrial and consumer robotic systems.

In particular, the course aims to:

ERC1. teach advanced system level design, documentation and implementation approaches and provide practical experience in the development and prototyping of electronic systems in the context of robotics using innovative product design methodologies, platforms and tools.

ERC2. explore broader issues concerning the adoption and processes of robotic systems and their cognitive systems including legislation for robotic devices, safety considerations and product life cycle

ERC3. teach the theoretical background and develop practical skills to analyse, design and test practical control systems for use in the field of robotic systems

ERC4. develop skills in the deployment and programming of real-time control systems and smart instrumentation in robotic systems by providing first-hand experience in prototyping a robotic system.

ERC5. teach and deploy mathematical and software based tools to analyse, model and describe the motion and behaviour of robotic devices with limbs that allow multiple degrees of freedom.

ERC6. deploy software tools to design and test algorithms for smart instrumentation and show how smart image sensor systems can be developed using standard image processing techniques, media interfaces and devices to enable a robot to undertake decision making tasks on complex data.

MSc Electronics with Embedded Systems

In addition, the MSc in Electronics with Embedded Systems aims to produce postgraduates with an advanced level of understanding in the design of real-time embedded systems for time-critical, power sensitive applications. In particular the course will provide in-depth critical understanding of the underlying principles as well as the use and deployment of requirements analysis techniques, design methodologies, design process methodologies, embedded systems programming, common 32-bit and 8-bit Micro-Controller-Unit (MCU) architectures, smart instrumentation devices and the latest development tool chains.

Practical skillset development is emphasized throughout the course; the student will design, build and test embedded systems, these activities will be supported by our laboratory environment. Students will be taught the theory, protocol and the efficient use of both analogue and digital interfaces and sensor devices. Complex time-critical system requirements will be met by teaching the principles of and using a Real-Time-Operating-System (RTOS). In addition the course will provide an in-depth discussion of the underlying power management hardware sub-systems within modern MCUs and will show and use software techniques that will exploit these to reduce power consumption.

Broader consideration of embedded system design will be explored by investigating how system cost, choice of design process, implementation and performance are informed or controlled by factors such as risk, operating environment, product life-cycle, software life-cycle, safety and regulation. It is intended that the course will re-focus existing knowledge held by the student in software engineering and hardware engineering and deliver a set of enhanced practical skills that will enable the student to fully participate in this multi-disciplined, fast expanding and dominating engineering sector of embedded systems.

In particular, the course aims to:

EES1. teach advanced system level design, documentation and implementation approaches and provide practical experience in the development and prototyping of embedded systems using innovative product design methodologies, platforms and tools.

EES2. explore broader issues concerning the design and application of embedded systems including risk analysis, costs, operating environment, product and software life-cycle, regulation, quality insurance processes and design process choices for mission and safety critical embedded systems.

EES3. provide a first-hand experience in the requirements analysis, design, build and test, together with the use of the latest development tools, by getting the student to prototype a stand-alone micro-controller application.

EES4. develop know-how in the use, critical evaluation and deployment of the latest development systems, software solutions, sensors, interface protocol, instrumentation, modern Micro-Controller-Unit (MCU) architectures and other external hardware sub-systems to realise a reliable ,efficient and timely solutions.

EES5. explain and deploy advanced software techniques to exploit the underlying power management architecture found in modern MCUs to realise low power solutions.

EES6. teach supporting theory, apply scheduling algorithms and use existing and emerging Real-Time-Operating Systems (RTOS) to satisfy complex real-time system requirements.

MSc Electronics with System-on-Chip Technologies

In addition, the MSc Electronics with System-On-Chip Technologies aims to produce postgraduates with an advanced understanding of the various routes to implementing systems-on-chip (SoC) and with hands-on experience of the design of such systems using several approaches to their implementation.

In particular, the course aims to:

ESC1. teach advanced system level design, documentation and implementation approaches and provide practical experience in the development of systemon-chip solutions using popular design methodologies and tools chains used in industry.

ESC2. explore broader issues concerning the design and implementation of systemon-chip solutions and their final application areas including quality insurance, ethics, risk analysis, regulation, legislation, intellectual property rights and lifecycle.

ESC3. produce students who are “silicon qualified” by providing them with a complete SoC design experience by setting a framework of activities that allow the student to use industry-standard Computer-Aided-Engineeringuse industry-standard Computer-Aided-Engineering (CAE) software tools for the fast and accurate design, simulation and verification of integrated circuits.

ESC4. establish proficiency in custom integrated circuit design at various levels of system hierarchy including realisation of algorithmic specifications, behavioural modelling, logic synthesis, digital design, transistor-level design and layout-level design.

ESC5. promote an awareness of, and competence in dealing with, the issues specific to VLSI system design; in particular, issues of testability and complexity management.

ESC6. Introduce an armoury of possible architectural solutions to particular system requirements especially in applications requiring very high computational efficiency such as DSP.

MSc Electronics with Medical Instrumentation
In addition, the MSc in Electronics with Medical Instrumentation aims to produce postgraduates with an understanding of medical instrumentation based systems used for monitoring; detecting and analysing biomedical systems as well as professional engineering skills required to design and implement such systems.

The course will develop practical skill sets and an in-depth understanding of state-of-the-art tools and algorithms that can be used to implement and test diagnostic devices, therapeutic devices, medical imaging equipment and medical instrumentation devices. In particular the course will explore the use of Matlab and Simulink to develop and test medical signal and image processing algorithms with an aim to prototype low-cost diagnostic equipment. This will be placed into context by further discussing the functionality, underlying principles, accessibility and limitations of a range of existing medical equipment and future trends. The course will also provide an overview of medical transducers and biosensors and provide a framework of hands-on activities to deepen the practical skillset of the student by allowing the student to understand and explore their use.

The course broadens the discussion of medical equipment and its design by investigating a range of issues including medical equipment regulation, user requirements, impacts of risk, regulatory practice, legislation, quality insurance mechanisms, certification, ethics and ‘health and safety’ assessment. These issues are then put into context by assessing how they impact the design process, the overall design of the system and costs.

The course will enable a student with an interest in medical electronics to re-focus existing knowledge gained in software engineering, embedded systems engineering and/or electronic systems engineering and will deliver a set specialist practical skills and a deeper understanding of the underlying principles of medical physics. A graduate from this course will be able to immediately participate in this multi-disciplined engineering sector of biomedical and medical instrumentation systems design.

In particular, the course aims to:

EMI1. teach advanced system level design, documentation and implementation approaches and provide practical experience in the development and prototyping of medical diagnostic equipment, medical instrumentation and therapeutic equipment using innovative solutions, platforms and tools.

EMI2. explore broader issues concerning the design and application of medical equipment including risk analysis, costs, operating environment, user requirements, product and software life-cycle, regulation, quality insurance processes and design process choices for safety critical medical electronic systems.

EMI3. provide first-hand experience in requirements identification, specification, design, build and test of a low-cost medical device.

EMI4. develop in-depth understanding of medical physics and human anatomy then use this to help understand and explore the operation of existing medical image techniques and the design and implementation of medical equipment.

EMI5. teach state of the art algorithms in the area of medical signal processing and image processing that can be applied to medical instrumentation, therapeutic equipment and diagnosis equipment.

EMI6. explore and assess the fundamental principles, architectures, interface requirements, functionality and characteristics of existing bio-medical equipment and bio-medical instrumentation, bio-sensors, transducers and electrodes and identify their limitations and application areas through theory and experimentation.

Employment and further study opportunities

Today's organisations need graduates with both good degrees and skills relevant to the workplace, i.e. employability skills. The University of Westminster is committed to developing employable graduates by ensuring that:

- Career development skills are embedded in all courses
- Opportunities for part-time work, placements and work-related learning activities are widely available to students
- Staff continue to widen and strengthen the University's links with employers in all sectors, involving them in curriculum design and encouraging their participation in other aspects of the University's career education and guidance provision
- Staff are provided with up-to-date data on labour market trends and employers' requirements, which will inform the service delivered to students.

The subject areas covered within the four pathways in the electronic suite of MSc courses offer students an excellent launch pad which will enable the successful graduate to enter into these ever expanding, fast growing and dominant areas within the electronic engineering sector. With ever increasing demands from consumers such as portability, increased battery life and greater functionality combined with reductions in cost and shrinking scales of technologies modern electronic systems are finding ever more application areas. This has led to an explosion in embedded system devices, a requirement to have system on-chip solutions to reduce the size and power consumption of devices and an increase in their market share as medical devices and robotic devices enter the main stream consumer market.

Industry and users have fed the explosion in demand for advancements in medical electronics. In particular demands for complex user interfaces, demands to reduce equipment costs, demands for greater accessibility of equipment and the demand for greater portability of equipment has become common place. This has led to expanding opportunities within the modern electronic engineering sector. In particular there is a need for engineers that can solve problems requiring a multi-disciplined approach covering skills from software engineering, control engineering, digital electronic systems engineering, analogue electronic engineering, medical physics, and mechanics amongst others.

The MSc degrees offered will provide the foundations required to re-focus existing knowledge and enter the world of multi-disciplined jobs. Possible job titles that a successful graduate with the relevant background education and experience may inspire to include:

- Electronic systems design engineer
- Robotic systems design engineer
- Embedded systems design engineer
- System-on-chip embedded systems engineer
- Measurements and instrumentation engineer
- Medical electronic design engineer
- Control systems engineer
- Plant control engineer
- Computer systems engineer
- Software engineer

In various industries such as:

- Electronic systems industry
- Medical equipment manufacturers
- Assembly line manufacturers
- Robotics and home help industries
- Logistics and distribution industries
- Instrumentation industry
- Transport industries
- Automobile industry
- Aviation industry
- Consumer industry
- Life-style industry
- Toy industry
- Security and surveillance industry
- Petro-chemical industry

The lists above are not prescriptive or exhaustive. There are many companies that require engineers that have good software and hardware skills combined with a high level of knowledge in robotic systems and medical technologies. This has increased tremendously over the past few years as digital electronic systems and system-on-chip solutions have led to a convergence within these subject areas. Despite the high demand for engineers that are competent in hardware and software disciplines, currently the supply of good systems engineers, that can fulfil all the requirements of these sectors, is too small. This has led to increased demand as companies scramble to get the best candidates that they can.

Learning outcomes

General Learning Outcomes
Knowledge and understanding

Graduates will satisfy the following criteria:

G1: they will be able to demonstrate their knowledge and understanding of essential facts, concepts, theories and principles pertaining to their area of engineering, and its underpinning science and mathematics. They will appreciate the social, environmental, ethical, economic and commercial considerations affecting the exercise of their engineering judgement.

Specific skills

G2: they will be able to apply appropriate quantitative science and engineering tools to the analysis of problems. They will be able to demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs. They will be able to comprehend the broad picture and thus work with an appropriate level of detail.

G3: they will possess practical engineering skills acquired through, for example, work carried out in laboratories; in project work; in design work; and in the use of computer software in design and analysis.

Key transferable skills

G4: they will have developed transferable skills that will be of value in a wide range of situations. These skills include:

- The ability to exercise initiative and personal responsibility whilst working with others.
- The ability to plan self-learning and improve performance, as the foundation for lifelong learning
- The ability to communicate effectively through written reports and presentations and the ability to handle competently technical questioning.
- The ability to use effectively general IT and information retrieval facilities.
- The ability to develop, monitor and update a plan, to reflect a changing operating environment.
- The ability to monitor and adjust a personal programme of work on an on-going basis, and to learn independently;
- The ability to learn new theories, concepts, methods, etc and apply these to solve problems in unfamiliar situations.

Specific Learning Outcomes

1. **Science and Mathematics**

MSc Electronics with Robotic and Control Systems

Graduates will be able to demonstrate:

SM1fl a comprehensive understanding of the mathematical tools used to model the behaviour of dynamic systems, kinematic systems and the underlying control systems that are used to realise the implementation of robotic systems;

SM2fl an awareness of the limitations of current practices, technologies and state-of-the-art techniques used in robotic systems and their sub-systems and how these limitations affect the adoption of robotic systems in various application areas;

SM3fl know-how in the analysis, modelling, deployment and underlying principles of cognitive systems, mechanical systems and image systems used in robotic systems together with a broader understanding of legislation, safety, ethical and sociological issues and how these limit or influence the adoption and/or design of robotic systems in both individual coursework's and a final complex engineering project.

MSc Electronics with Embedded Systems

Graduates will be able to demonstrate:

SM1fl a comprehensive understanding of the mathematical tools, mathematical principles and scientific principles required to solve a given problem including the following: power consumption within an embedded system, common bus interfaces, actuators, signal acquisition systems, sensory devices and static and dynamic scheduling algorithms for soft and hard real-time systems;

SM2fl an awareness of the limitations of the; latest Micro-Controller Unit (MCU) architectures including functionality, capacity, peripheral sets and power management systems; development systems, sensor devices, data converters and actuators, wired and wireless interfaces; Real-Time Operating Systems (RTOS) and scheduling algorithms together with insight into the latest trends in embedded system tool development and technologies;

SM3fl the ability to critical evaluate the suitability and then effectively deploy a given design process, development system, programming style and language, Micro-Controller-Unit (MCU) architecture, communication standard and/or sub-system, task scheduling algorithm or external sub-system to ensure that the timing, functional requirements, ethical concerns, legislative requirements, regulatory processes and certification requirements of a given embedded system can be met, in both individual practical coursework's and a final complex engineering project.

MSc Electronics with System-on-Chip Technologies

Graduates will be able to demonstrate:

SM1fl a comprehensive understanding of the scientific principles and underlying mathematics of microelectronic systems and related disciplines including; the relationship between technology scaling , clock speed and power dissipation; principles of PMOS, NMOSand CMOS technologies and the underlying implementation of logic gates; logic analysis and synthesis; signal processing systems and communication systems;

SM2fl an awareness of the limitations of existing technologies and tool chains together with an awareness of the advantages of ever smaller scales of integration and advancements in development tool chains, testing strategies and design methodologies related to microelectronics and SoC design methodologies;

SM3fl an understanding of concepts from a range of application areas for System-on-Chip solutions, and the ability to apply them effectively in engineering projects.

MSc Electronics with Medical Instrumentation

Graduates will be able to demonstrate:

SM1fl a comprehensive understanding of the underlying; science of biomedical equipment, therapeutic equipment and biosensors; mathematical principles of image and signal processing; physical principles and dynamics of biomedical instrumentation;

SM2fl a critical awareness of the functionality, accessibility and cost of existing systems and insights of how new low-power highly integrated System-On-Chip solutions, fast prototyping embedded system solutions and tool chains, increased performance of array based image sensors and the latest low-cost consumer technologies can be used to increase accessibility, reduce user interface complexity, reduce cost and size to enable a wider range of people to benefit;

SM3fl understanding of the underlying principles and concepts of medical instrumentation through critical evaluation of existing biomedical equipment in terms of physical principles, sensor dynamics and electronic circuitry used; the ability to apply the functionality of various biosensors, transducers and electrodes in the implementation of a device that will measure physiological variables, in both individual coursework's and a final complex engineering project.

2. **Engineering Analysis**

MSc Electronics with Robotic and Control Systems

Graduates will be able to demonstrate:

EA1fl in-depth know-how in the analysis and modelling of various complex sub-systems of robotic systems to facilitate optimal performance, robustness of control and stability together with an understanding of the limits of the models and analysis tools used;

EA2fl the ability to evaluate and review the research and/or industry issues in the area of robotic systems and control within a project domain given fundamental knowledge of the analysis and design tools used for robotic systems and where appropriate investigate and appraise new emerging technologies;

EA3fl the ability to use effectively appropriate methods of gathering and analyzing information including research data to formulate a proposal that presents and/ or defends research and current practice in the area of robotic and control systems and then apply the appropriate innovative techniques, adaptation of an existing engineering analytic method or use of appropriate analysis techniques and tools to solve a complex real problem.

MSc Electronics with Embedded Systems

Graduates will be able to demonstrate:

EA1fl the ability to perform requirements analysis of complex embedded systems to identify overall timing requirements and functional requirements; the ability to use analytic tools to analyse the functionality and timing of various hardware sub-systems, software processes and scheduling systems deployed to ensure that the real-time constraints and overall functional requirements identified can be met; the ability to inform the design process based on the analysis undertaken with an understanding of the limitations and practical implications of the analytical tools used;

EA2fl the ability to evaluate and review the research and/or industry issues in the area of embedded systems design methodology within a project domain given fundamental knowledge and where appropriate investigate and appraise new emerging technologies and methodologies;

EA3fl the ability to use effectively appropriate methods of gathering and analysing information including research data to formulate a proposal that presents and/ or defends research and current practice in the area of embedded systems development and then apply the appropriate innovative techniques, adaptation of an existing engineering methodology or use of appropriate design processes and tools to solve a complex real problem.

MSc Electronics with System-on-Chip Technologies

Graduates will be able to demonstrate:

EA1fl the ability to breakdown a task into fundamental building blocks, identify the core timing and functional requirements of these blocks, and deploy state-of-the-art analysis tools to simulate functionality and timing, estimate silicon area and estimate power dissipation, then inform the design process based on an interpretation of these results given the understanding of the limitations of such tools for a complex system-on-chip solution;

EA2fl the ability to evaluate and review the research and/or industry issues in the area of System-on-Chip (SoC) technologies and tool chains within a project domain given fundamental knowledge and where appropriate investigate and appraise new emerging technologies and methodologies;

EA3fl the ability to use effectively appropriate methods of gathering and analysing information including research data to formulate a proposal that presents and/ or defends research and current practice in the area of System-on-Chip (SoC) design and then apply the appropriate innovative techniques, adaptation of an existing design methodology or use of the appropriate design processes and tools to solve a complex real problem.

MSc Electronics with Medical Instrumentation

Graduates will be able to demonstrate:

EA1fl the ability to apply analysis techniques and tools to evaluate and apply the functionality of various analogue and digital circuits, biosensors, transducers, electrodes and optical/ medical signal processing techniques for the measurement of physiological variables and the ability to use these results to inform the design and implementation of diagnostic and therapeutic equipment;

EA2fl the ability to evaluate and review the research and/or industry issues in the area of medical instrumentation within a project domain given fundamental knowledge and where appropriate investigate and appraise new emerging technologies and methodologies;

EA3fl the ability to use effectively appropriate methods of gathering and analysing information including research data to formulate a proposal that presents and/ or defends research and current practice in the area of medical instrumentation and then apply the appropriate innovative techniques, adaptation of an existing design or use of the appropriate design processes and tools to solve a complex real problem.

3. **Design**

MSc Electronics with Robotic and Control Systems

Graduates will be able to demonstrate:

D1fl the ability of using knowledge gained to determine the initial requirements of a given robotics and/or control problem with an incomplete or uncertain description by analysing, modelling and solving the dynamic and kinematic behaviour and/or path trajectories of a robotic system; the ability to determine an initial specification for the solution based on the requirements identified; the ability to implement a prototype test bench by writing real-time software for the solution on a given development platform and through experimentation quantify the effects of various configuration and parameter choices in respect of functionality, performance, robustness and stability to produce the final design and solution;

D2fl the ability to undertake a complex project in the area of robotic and control systems that is unfamiliar; the ability to select a suitable design process and methodology and apply them; the ability to communicate the objective defence of the chosen design process against other possible selections taking into account the nature of the technical solution and a broader range of engineering issues including professional codes of practice, commercial risk, sustainability, social impact, legislation, regulatory practice, robo-ethics and risk analysis;

D3fl the ability to independently work on and solve complex real problems in the robotic and control systems area from specification to final build and test, by applying, modifying where appropriate, and deploying advanced engineering techniques and tools to solve new design problems; the ability to critically evaluate their own work knowing current solutions and practices, identifying limitations of their work and assessing contributions of their work with respect to the existing knowledge base.

MSc Electronics with Embedded Systems

Graduates will be able to demonstrate:

D1fl the ability of using theoretical knowledge and practical understanding gained of the timing requirements and behaviour of real world interfaces, signal acquisition sub-systems, inter-processor communication systems, external hardware subsystems, Micro-Controller-Unit (MCU) architectures, peripheral resources, documentation tools, real-time software tools and scheduling algorithms to determine and document the initial requirements and specification of a complex embedded system problem with an incomplete or uncertain description; the ability to build a prototype device based on the initial requirements and specification identified and use analytic and quantative experimental methods informed by the understanding of the system under test to establish a final solution that meets all system requirements through an iterative design, build, code and test approach;

D2fl the ability to undertake a complex project in the area of embedded systems that is unfamiliar; the ability to select a suitable design process and methodology and apply them; the ability to communicate the objective defence of the chosen design process against other possible selections taking into account the nature of the technical solution and a broader range of engineering issues including professional codes of practice, commercial risk, sustainability, social impact, legislation, regulatory practice, ethical issues and risk analysis;

D3fl the ability to independently work on and solve complex real problems in the embedded systems development area from specification to final build and test, by applying, modifying where appropriate, and deploying advanced engineering techniques and tools to solve new design problems; the ability to critically evaluate their own work knowing current solutions and practices, identifying limitations of their work and assessing contributions of their work with respect to the existing knowledge base.

MSc Electronics with System-on-Chip Technologies

Graduates will be able to demonstrate:

D1fl the ability of using theoretical knowledge and practical understanding of signal processing algorithms, intellectual property (IP) blocks, System-on-Chip Technologies and state-of-the-art software tool chains to design, enter, synthesise and test a complex System-on-Chip (SoC) solution for a problem that is not fully specified or uncertain; the ability to identify functional sub-blocks and then use their understanding of logic design, the target device and High-Level-Design language (HDL) tools to describe these sub-blocks and write a set of test bench files to test and verify the operation of these sub-blocks through logical and back annotated timing simulations for a given target device or silicon process; the ability to construct and apply an iterative experimental design process until all timing requirements and functional requirements are met as confirmed by the test bench files;

D2fl the ability to undertake a complex project in the area of System-on-Chip (SoC) design that is unfamiliar; the ability to determine system and/or algorithmic requirements and select a suitable design process and methodology and apply them; the ability to communicate the objective defence of the chosen design process and methodology against other possible selections taking into account the nature of the technical solution and a broader range of engineering issues including professional codes of practice, commercial risk, sustainability, social impact, legislation, regulatory practice, ethical issues and risk analysis;

D3fl the ability to independently work on and solve complex real problems using System-On-Chip (SoC) technologies from specification to final build and test, by applying, modifying where appropriate, and deploying advanced engineering techniques and tools to solve new design problems; the ability to critically evaluate their own work knowing current solutions and practices, identifying limitations of their work and assessing contributions of their work with respect to the existing knowledge base.

MSc Electronics with Medical Instrumentation

Graduates will be able to demonstrate:

D1fl the ability to critically evaluate and use theoretical understanding of bio-engineering methodologies to monitor and diagnose biological signals irregularities; understanding of underlying scientific principles and the functionality of various biosensors, transducers and electrodes to help identify the requirements and specification of a complex problem in the area of medical instrumentation who's solution is not fully described and/or uncertain; the ability of the student to quantify the uncertainty of the specification and behaviour of the hardware sub-systems used in the build of a prototype medical device and identify how this uncertainty may change the overall functionality of the device; the ability of a student to construct a suitable test bench and apply knowledge gained to devise an experimental iterative design approach to produce a final solution that meets the required specification;

D2fl the ability to undertake a complex project in the area of medical instrumentation that is unfamiliar; the ability to select a suitable design process and methodology and apply them; the ability to communicate the objective defence of the chosen design process against other possible selections taking into account the nature of the technical solution and a broader range of engineering issues including professional codes of practice, commercial risk, sustainability, social impact, legislation, regulatory practice, ethical issues and risk analysis;

D3fl the ability to independently work on and solve complex real problems in the area of medical instrumentation from specification to final build and test, by applying, modifying where appropriate, and deploying advanced engineering techniques and tools to solve new design problems; the ability to critically evaluate their own work knowing current solutions and practices, identifying limitations of their work and assessing contributions of their work with respect to the existing knowledge base.

4. Economic, Legal, Social, Ethical and Environmental Context

MSc Electronics with Robotic and Control Systems

Graduates will be able to demonstrate:

ET1fl the ability to fully articulate the importance of high levels of professional and ethical conduct given knowledge and understanding of development costs and the sociological impacts caused by the use and cognitive reasoning power of modern robotic devices; the ability of the student to write technical reports to prescribed standards and formats, to work to deadlines and to critically evaluate their work and give a critical reflection of the planning and management of their professional development;

ET2fl the ability to communicate an objective defence of the chosen design process taking into account commercial risk, codes of practice, ethical requirements, safety requirements and the social impact of robotic and control systems ;

ET3fl the ability to communicate an objective defence of the chosen business arguments taking into account commercial risk, codes of practice, ethical requirements, safety requirements and the social impact of robotic and control systems ;

ET4fl the ability to identify required resources and defend and deploy methodologies, business arguments and design processes that will ensure sustainable development;

ET5fl the ability to communicate an objective defence of the design process, design methodology and/or business arguments chosen given the regulatory requirements in the area of robotic and control systems;

ET6fl the ability of the student to evaluate risks related to the environment, safety of robotic and control devices and where appropriate commercial risk.

MSc Electronics with Embedded Systems

Graduates will be able to demonstrate:

ET1fl an awareness of the need for a high level of professional and ethical conduct by carefully analysing a complex real embedded system problem, then selecting and deploying a suitable design process, then informing the design process by identifying ethical issues related to the underlying application and product life-cycle requirements; the ability of the student to write technical reports to prescribed standards and formats, to work to deadlines and to critically evaluate their work and give a critical reflection of the planning and management of their professional development;

ET2fl the ability to communicate an objective defence of the chosen design process taking into account commercial risk, codes of practice, ethical requirements, safety requirements and the social impact of the underlying application area of a given safety critical embedded system solution;

ET3fl the ability to communicate an objective defence of the chosen business arguments and design process given knowledge of various design process methodologies, business models, quality assurance systems, regulatory practices and certification requirements for a complex safety critical embedded system application;

ET4fl the ability to identify required resources and defend and deploy methodologies, business arguments and design processes that will ensure sustainable development;

ET5fl an awareness of the regulatory requirements in the application area for a given embedded system solution and how these will impact on the design process and design methodology;

ET6fl the awareness and ability to evaluate risks related to the environment, health and safety and where appropriate commercial risk for a given embedded systems application area.

MSc Electronics with System-on-Chip Technologies

Graduates will be able to demonstrate:

ET1fl the ability to show an awareness and clearly indicate the importance of high levels of professional and ethical conduct by initiating processes and identifying system requirements that are fully informed by ethical issues in the application area of a given System-On-Chip (SoC) solution; the ability of the student to write technical reports to prescribed standards and formats, to work to deadlines and to critically evaluate their work and give a critical reflection of the planning and management of their professional development;

ET2fl the ability to communicate an objective defence of the chosen design process and/or design methodology taking into codes of practice, commercial risk and the social impact of the underlying application area for a given System-On-Chip (SoC) solution;

ET3fl the ability to communicate an objective defence of the chosen design process given knowledge of various design process methodologies, business models, quality assurance systems, regulatory practices and certification requirements for the underlying application area for a given System-On-Chip (SoC) solution;

ET4fl the ability to defend and deploy methodologies, business arguments and design processes that will ensure sustainable development for the entire system including the System-On-Chip (SoC) solution;

ET5fl an awareness of the regulatory requirements in the application area for a given System-On-Chip (SoC) solution and how these will impact on the selection of a given design process and design methodology;

ET6fl an awareness and ability to evaluate risks related to the environment, health and safety and where appropriate commercial risk for the underlying application area for a given System-On-Chip (SoC) solution.

MSc Electronics with Medical Instrumentation

Graduates will be able to demonstrate:

ET1fl the ability to show an awareness and clearly indicate the importance of the high levels of professional and ethical conduct required in the area of medical instrumentation by initiating processes and identifying system requirements that are fully informed by general and medical ethics; the ability of the student to write technical reports to prescribed standards and formats, to work to deadlines and to critically evaluate their work and give a critical reflection of the planning and management of their professional development;

ET2fl the ability to communicate an objective defence of the chosen design process and/or design methodology for the design of a given medical instrument taking into codes of practice, commercial risk and impacts on society including the accessibility and importance of the diagnosis and/or treatment solution;

ET3fl the ability to communicate an objective defence of the chosen design process, business model and/or business arguments given knowledge of various design process methodologies, business models, quality assurance systems, regulatory practices, legislation and certification requirements associated with the design of a given medical instrumentation device;

ET4fl the ability to defend and deploy methodologies, business arguments and design processes that will ensure sustainable development;

ET5fl an awareness of the regulatory requirements governing the design of a given medical instrumentation device and how these will impact on the selection and implementation of the design process and design methodology;

ET6fl an awareness and ability to evaluate risks related to the environment, health and safety and where appropriate commercial risk for the underlying medical application area;

5. Engineering Practice

MSc Electronics with Robotic and Control Systems

Graduates will be able to demonstrate:

EP1fl an in-depth understanding of the principles, limitations, electrical and timing characteristics, design and/or implementation, deployment and application of vision systems, media interfaces and instrumentation such as sensors and actuators in the context of robotic and control systems;

EP2fl the ability to use effectively methods of gathering and analysing information and develop a thorough understanding and critical evaluation of current practices used in robotic and control systems; the ability to identify and critically evaluate possible future trends in robotic and control systems;

EP3fl the ability to select, report and apply a suitable design process and design methodology given commercial and industrial constraints for a complex robotic and/or control system problem;

EP4fl understanding of different roles within an engineering team and exercise initiative and personal responsibility within their role;

MSc Electronics with Embedded Systems

Graduates will be able to demonstrate:

EP1fl know-how in the fundamental underlying principles, electrical characteristics, timing characteristics, application and deployment of hardware sub-systems; Micro- Controller-Unit (MCU) power management systems, MCU debugging tools, interface sub-systems, external hardware sub-systems and software development tools to implement low power real-time solutions for a given application area that meets all real-time constraints and functional requirements;

EP2fl the ability to use effectively methods of gathering and analysing information and develop a thorough understanding and critical evaluation of current tools and practices used to develop embedded systems for a given application area; the ability to identify and critically evaluate possible future trends in respect of embedded system development tools;

EP3fl the ability to select, report and apply a suitable design process and design methodology given a range of commercial and industrial constraints for a given embedded system problem;

EP4fl understanding of different roles within an engineering team and exercise initiative and personal responsibility within their role;

MSc Electronics with System-On-Chip Technologies

Graduates will be able to demonstrate:

EP1fl an advanced level of knowledge and understanding of Computer Aided Design (CAD) tools used to enter, simulate and synthesise digital logic and mixed circuit designs including knowledge of logic level abstraction, library based intellectual property (IP) solutions, physical layout, electrical characteristics of the underlying fabrication technology and manufacture and/or configuration of devices;

EP2fl the ability to use effectively methods of gathering and analysing information and develop a thorough understanding and critical evaluation of current tools and practices used to implement System-On-Chip (SoC) solutions for a given application area; the ability to identify and critically evaluate possible future trends in System-On- Chip (SoC) design methodology and development toolsets and discus the advantages this may afford;

EP3fl the ability to select, report and apply a suitable design process and design methodology given commercial and industrial constraints for a given problem;

EP4fl understanding of different roles within an engineering team and exercise initiative and personal responsibility within their role;

MSc Electronics with Medical Instrumentation

Graduates will be able to demonstrate:

EP1fl an advanced level of knowledge and understanding of transducers, biosensors, electrodes, sensor dynamics, electronic circuits and components used to implement diagnostic and therapeutic devices;

EP2fl the ability to use effectively methods of gathering and analysing information and develop a thorough understanding and critical evaluation of current tools and practices used to develop medical instrumentation devices; the ability to identify and critically evaluate possible future trends and demands for medical equipment and the implications this may have on accessibility, risk, society and general patient wellbeing;

EP3fl the ability to select, report and apply a suitable design process and design methodology given commercial and industrial constraints for the implementation of a specific medical device;

EP4fl understanding of different roles within an engineering team and exercise initiative and personal responsibility within their role;

Course structure

This section shows the core and option modules available as part of the course and their credit value. Full-time Postgraduate students study 180 credits per year.

Each of them consists of three taught modules (40 credits each) plus an individual project (60 credits)

MSc Electronics with Embedded Systems

Credit Level 7				
Module code	**Module title**	**Status**	**UK credit**	**ECTS**
E1	Electronics	Core	40	20
E2.2	Embedded Systems	Core	40	20
P1	Project	Core	60	30
One from:				
E2.1	Robotic and Control Systems	Option	40	20
E2.3	System-on-Chip Technologies	Option	40	20
E2.4	Medical Instrumentation	Option	40	20
CN1	Computer Networks	Option	40	20
N2.1	Security	Option	40	20
N2.2	Communication Networks	Option	40	20
N2.3	Cloud Technologies	Option	40	20
TC1	Telecommunications	Option	40	20
C2.1	Digital Signal Processing	Option	40	20
C2.2	Satellite and Broadband Communications	Option	40	20
C2.3	Wireless Technologies	Option	40	20

MSc Electronics with Robotic and Control Systems

Credit Level 7				
Module code	**Module title**	**Status**	**UK credit**	**ECTS**
E1	Electronics	Core	40	20
E2.1	Robotic and Control Systems	Core	40	20
P1	Project	Core	60	30
One from:				
E2.2	Embedded Systems	Option	40	20
E2.3	System-on-Chip Technologies	Option	40	20
E2.4	Medical Instrumentation	Option	40	20
CN1	Computer Networks	Option	40	20
N2.1	Security	Option	40	20
N2.2	Communication Networks	Option	40	20
N2.3	Cloud Technologies	Option	40	20
TC1	Telecommunications	Option	40	20
C2.1	Digital Signal Processing	Option	40	20
C2.2	Satellite and Broadband Communications	Option	40	20
C2.3	Wireless Technologies	Option	40	20

MSc Electronics with System-on-Chip Technologies

Credit Level 7				
Module code	**Module title**	**Status**	**UK credit**	**ECTS**
E1	Electronics	Core	40	20
E2.3	System-on-Chip Technologies	Core	40	20
P1	Project	Core	60	30
One from:				
E2.1	Robotic and Control Systems	Option	40	20
E2.2	Embedded Systems	Option	40	20
E2.4	Medical Instrumentation	Option	40	20
CN1	Computer Networks	Option	40	20
N2.1	Security	Option	40	20
N2.2	Communication Networks	Option	40	20
N2.3	Cloud Technologies	Option	40	20
TC1	Telecommunications	Option	40	20
C2.1	Digital Signal Processing	Option	40	20
C2.2	Satellite and Broadband Communications	Option	40	20
C2.3	Wireless Technologies	Option	40	20

MSc Electronics with Medical Instrumentation

Credit Level 7				
Module code	**Module title**	**Status**	**UK credit**	**ECTS**
E1	Electronics	Core	40	20
E2.4	Medical Instrumentation	Core	40	20
P1	Project	Core	60	30
One from:				
E2.1	Robotic and Control Systems	Option	40	20
E2.2	Embedded Systems	Option	40	20
E2.3	System-on-Chip Technologies	Option	40	20
CN1	Computer Networks	Option	40	20
N2.1	Security	Option	40	20
N2.2	Communication Networks	Option	40	20
N2.3	Cloud Technologies	Option	40	20
TC1	Telecommunications	Option	40	20
C2.1	Digital Signal Processing	Option	40	20
C2.2	Satellite and Broadband Communications	Option	40	20
C2.3	Wireless Technologies	Option	40	20

Please note: Not all option modules will necessarily be offered in any one year.

Learning, teaching and assessment methods

Teaching

The taught portion of the courses is delivered in three highly concentrated 40 credit modules which we call learning modules. The teaching within these modules is delivered in the format of an industrial short course. This delivery style allows students to rapidly gain a full overview of the horizons of the subject matter and furthermore enables the student to achieve a state of relevant functionality without a great deal of elapsed time. This can be especially advantageous if the student is attending on an occasional basis, or has urgent needs of immediate skill in a given topic area at his/her place of work.

Within the taught portion of each module there is adequate time given to “hands-on” practice of concepts and tools taught. The student usually experiences practical in-place application of the knowledge being dispensed during the taught portion of the module on most days. Any assignments and exercises carried out within the taught portion of a module are meant to develop basic capability and, as such, serve as a useful vehicle for sharpening the skills baseline required for undertaking the portfolio of work described within the Independent Learning Package (ILP).

The ILP consists of a collection of short answer, long answer and open ended project based assignments and tasks that must be solved independently by the student. The project based task within the ILP will require the student to exercise and use principles, concepts and technologies within the specialism of the module to design, implement and verify the operation of a complex real system. In some modules the project component maybe in the form of a group project whilst in other modules the project component maybe in the form of an individual project.

Each taught module is allocated 400 hours of study time. Out of this time 70 hours or 10 working days are allocated to the delivery of the taught portion of the module, 16 hours are allocated to additional tutorial sessions and the remaining 314 hours are allocated to the student to work on and complete the ILP. To enable the student to further practice and solidify their understanding of material taught and their abilities in using the relevant tool sets additional tutorials outside of the taught portion of the module are provided. These tutorials provide just in time practice sessions during the ILP period of the module. The ILP is where the remaining learning takes place, where abundant 'soak-time' to solve the portfolio of work described within the ILP package document is given. The performance of work carried out for the ILP can take place at the university, within the students place of work or at their home.

Assessment

Assessment of Learning Modules

The assessment for the learning modules is formed by setting a portfolio of work known as an Independent Learning Package (ILP) that the student must complete. The ILP typically consists of short answer, long answer and open ended project based assignments and small tasks. The student must submit their completed ILP work in the form of an ILP report that will contain a critical, reflective and detailed description of the independent work carried out by the student and the results achieved by the student.

Unlike the assignments given in the ILP exercises carried out in the taught portion of a learning module are not assessed, these exercises are meant to develop basic capability and, as such, serve as a useful vehicle for sharpening the skills baseline for undertaking the associated Independent Learning Package (ILP) – often through keen competition within the class. In summary, the taught portion of a module is not explicitly subject to assessment, whereas ILPs are.

Assessment is carried out when the student presents himself/herself for examination. This process has two phases: submission of all supporting written evidence (worked problems, design and simulation results, software programs, written reports and the like) in the form of an ILP report, followed by attendance for an oral defence of the work detailed in the ILP report. An ILP Review Panel, consisting of at least two members of staff, will be empowered to determine the level of achievement of the student by giving a 'Pass with Distinction', 'Pass with Merit', 'Pass' or 'Fail' judgement after thorough scrutiny of the written evidence and hearing the oral defence and to make a recommendation to the Assessment Board.

It will be the principal task of the panel to assess the student's competence through carrying out the assigned work, with respect to the norms of professional-level competence which pertain to that subject. The result is a 'Pass with Distinction', 'Pass with Merit', 'Pass' or 'Fail' judgement. Students must achieve at least a 'Pass' to be awarded the credits for that module.

How will you be supported in your studies?

Academic Support

Upon arrival, an induction programme will introduce you to the staff responsible for the course, the campus on which you will be studying, the Library and IT facilities, additional support available and to your Faculty Registry Office. You will be provided with the Course Handbook, which provides detailed information about the course. Each course has a course leader or Director of Studies. All students enrolled on a full-time course and part time students registered for more than 60 credits a year have a personal tutor, who provides advice and guidance on academic matters. The University uses a Virtual Learning Environment called Blackboard where students access their course materials, and can communicate and collaborate with staff and other students

Learning Support

The Academic Learning Development Centre supports students in developing the skills required for higher education. As well as online resources in Blackboard, students have the opportunity to attend Study Skills workshops and one to one appointments.

Learning support includes four libraries, each holding a collection of resources related to the subjects taught at that site. Students[1] can search the entire library collection online through the Library Search service to find and reserve printed books, and access electronic resources (databases, e-journals, e-books). Students can choose to study in the libraries, which have areas for silent and group study, desktop computers, laptops for loan, photocopying and printing services. They can also choose from several computer rooms at each campus where desktop computers are available with the general and specialist software that supports the courses taught at their Faculty. Students can also securely connect their own laptops and mobile devices to the University wireless network.

Support Services

The University of Westminster Student Affairs department provide advice and guidance on accommodation, financial and legal matters, personal counselling, health and disability issues, careers, specialist advice for international students and the chaplaincy providing multi-faith guidance. The University of Westminster Students' Union also provides a range of facilities to support students during their time at the University.

How do we ensure the quality of our courses and continuous improvement?

The course was initially approved by a University Validation Panel in 2015. The panel included internal peers from the University, academic(s) from another university and a representative from industry. This helps to ensure the comparability of the course to those offered in other universities and the relevance to employers.

The course is also monitored each year by the Faculty to ensure it is running effectively and that issues which might affect the student experience have been appropriately addressed. Staff will consider evidence about the course, including the outcomes from Course Committees, evidence of student progression and achievement and the reports from external examiners, to evaluate the effectiveness of the course. Each Faculty puts in to place an action plan. This may for example include making changes on the way the module is taught, assessed or even how the course is structured in order to improve the course, in such cases an approval process is in place.

A Course review takes place periodically to ensure that the curriculum is up-to-date and that the skills gained on the course continue to be relevant to employers. Students meet with review panels to provide feedback on their experiences. Student feedback from previous years e.g. from Course Committees is also part of the evidence used to assess how the course has been running.

How do we act on student feedback?

Student feedback is important to the University and student views are taken seriously. Student feedback is gathered in a variety of ways.

[1] Students enrolled at Collaborative partners may have differing access due to licence agreements.

- Through Course Committees students have the opportunity to express their voice in the running of their course. Student representatives are elected to Committee to expressly represent the views of their peer. The University and the Students' Union work together to provide a full induction to the role of the student representatives.

- Each Faculty also has its own Faculty Student Forum with student representatives; this enables wider discussions across the Faculty. Student representatives are also represented on key Faculty and university committees.

- All students are invited to complete a questionnaire before the end of each module. The feedback from this will inform the module leader on the effectiveness of the module and highlight areas that could be enhanced.

- The University also has an annual Postgraduate Taught Experience Survey or PTES which helps us compare how we are doing with other institutions, to make changes that will improve what we do in future and to keep doing the things that you value.

Please note: This programme specification provides a concise summary of the main features of the course and the learning outcomes that a student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided. This specification should be read in conjunction with the Course Handbook provided to students and Module Handbooks, which provide more detailed information on the specific learning outcomes, content, teaching, learning and assessment methods for each module.