Programme Specification

MSc European Masters in Embedded Computing Systems (2019-20)

This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided.

Awarding Institution	University of Southampton
Teaching Institution	Norwegian University of Science and Technology/Norges teknisk-naturvitenskapelige universitet i Trondheim, University of Kaiserslautern/Technische Universität Kaiserslautern, University of Southampton
Mode of Study	Full-time
Duration in years	2
Accreditation details	None
Final award	Master of Science (MSc)
Name of award	European Masters in Embedded Computing Systems
Interim Exit awards	Postgraduate Certificate in Higher Education
	Postgraduate Diploma in Higher Education
FHEQ level of final award	Level 7
UCAS code	N/A
Programme code	7971 7972
QAA Subject Benchmark or other external reference	
Programme Lead	Basel Halak (bh1m10)

Programme Overview

Brief outline of the programme

The Erasmus Mundus European Masters in Embedded Computing Systems (EMECS) is a two-years master's program. The degree is a joint programme between three Universities (Southampton – UK, Kaiserslautern – Germany and Trondheim – Norway) where the students spend their two years in two of these universities, one year at each. A total of 120 ECTS (European Credit Transfer and Accumulation System) credit points (240 CATS) must be acquired. The curriculum consists of a core program, an elective program and a Master's Thesis. The core program covers the fundamentals of Embedded Computing Systems and offers an equivalent education in all three institutions. The elective program reflects the specific profiles of the participating partner universities and their

associated research institutes.

The core program (60 ECTS/120 CATS) consists of three study areas:

- Embedded System Hardware Architectures
- System Software
- System-on-Chip (SoC) Design Methodology

The three partner universities have agreed on the contents of these core study areas. All teaching modules of the core program are mandatory to all students and need to be finished within the first year of study at one of the partner universities. The core program guarantees that all students can achieve an equivalent educational level regarding the basic principles of embedded system design and architecture. After completion of the core program, no matter at which partner institution, students will be able to take full profit of the elective program and project activities offered throughout the consortium.

The elective program (60 ECTS/120 CATS) consists of four study areas:

- Advanced Topics in Embedded Systems
- Communication & Signal Processing
- Automation & Control
- Microsystems

In addition to the taught elements worth 120 ECTS (240 CATS) there is an individual Masters Thesis project worth 30 ECTS (60 CATS).
These areas are offered by all partner universities. Each partner university contributes a number of teaching modules to each elective study area. The teaching modules within an elective study area are varying between universities and reflect specific local strengths, special application areas, design methodologies and architectures of embedded systems. Typically, a student will complete 60 ECTS (120 CATS) in one partner institution and 60 ECTS (120 CATS) at a second partner institution.

There are no mandatory teaching modules in the elective program. Every student is assigned a supervisor at each of the two partner universities that he or she attends. Based on the elective program an individual study plan is elaborated and mutually agreed on between the student and the supervisors.

Your contact hours will vary depending on your module/option choices. Full information about contact hours is provided in individual module profiles.

Learning and teaching

Modules consist of a combination of lectures, small group teaching, practical work, directed reading and coursework assignments. Most of the modules contain a laboratory or practical component which is delivered via hands-on practical sessions. One third of the course is an individual project within a research group or in industry, delivered by one-to-one supervision.

Assessment

Assessment is by a combination of written examinations and coursework. The proportion of examinations to coursework varies between modules. Depending on the choice of modules, about 50% of the marks will be derived from coursework, with the individual project assessed by dissertation. Coursework takes the form of problem solving exercises, laboratory reports with literature review components, design exercises, and individual and small-group projects. Experimental, research and design skills are also assessed through the Project Preparation module and the Individual Research Project by means of written exercises, presentation and the project dissertation.

Special Features of the programme

This programme will allow you to engage in highly specialised activities revolving around the production of system on chip design on both integrated circuit and advanced FPGA platforms. You will also be exposed to a wide range of industry standard equipment and simulation/modelling tools.

Please note: As a research-led University, we undertake a continuous review of our programmes to ensure quality enhancement and to manage our resources. As a result, this programme may be revised during a student's period of registration; however, any revision will be balanced against the requirement that the student should receive the educational service expected. Please read our Disclaimer to see why, when and how changes may be made to a student's programme.

Programmes and major changes to programmes are approved through the University's programme validation process which is described in the University's Quality handbook.

Educational Aims of the Programme

1) Develop original ideas and solve complex problems in new or unfamiliar environments, based on advanced knowledge of the principles and methodologies of embedded computing systems and related aspects of electronic engineering
2) Integrate knowledge and handle complexity in this area of electronic engineering, formulating sound judgements with incomplete or limited data
3) Communicate your conclusions and the underpinning knowledge and rationale clearly and unambiguously to specialist and non-specialist audiences
4) Develop your independent learning skills as required for continued professional development

Programme Learning Outcomes

Knowledge and Understanding

On successful completion of this programme you will have knowledge and understanding of:

A1. The scientific and technological principles underlying systems on chip (SOC) and more generic applications of electronic engineering to SOC design

A2. Techniques used for the fabrication of SOC electronic devices and components

A3. Methods for characterisation and analysis of SOC electronic devices and systems

A4. The design of electronic systems and devices, with a focus on SOC

Teaching and Learning Methods

A1, A2, A3, A4. Most modules consist of a combination of lectures, small group teaching, practical work, directed reading and coursework assignments. At the end of the taught part of the course you will undertake an individual project within a research group or in industry. The MSc dissertation and several courseworks contain a literature review component. Small group teaching, including all practical work, and the individual project accommodate different learning styles. One-on-one tutorials can support full-

class lectures, when required.

Assessment Methods

A1, A2, A3, A4. Your knowledge and understanding of each subject will be assessed through a combination of written examinations and coursework. The proportion of examinations to coursework varies between modules. Depending on your choice of modules, about 50% of your marks will be derived from coursework, with the individual project assessed by dissertation. Assessment is through a combination of unseen written examinations and assessed coursework in the form of problem solving exercises, laboratory reports with literature review components, design exercises, and individual and small-group projects.

Subject Specific Intellectual and Research Skills

On successful completion of this programme you will be able to:

B1. Specify and design Systems on Chip (SOC)

B2. Model and simulate the behaviour of parts of SOC elements and complete circuits at the appropriate level of detail using analogue or digital models where appropriate

B3. Verify a device design using advanced simulation and modelling tools and implement using IC layout techniques and FPGA based practical work

B4. Find, read, understand and explain scientific publications related to system on chip

B5. Undertake research into system on chip designs and applications

Teaching and Learning Methods

B1, B2, B3: Design skills are developed through individual practical work and the individual project. Modelling, simulation and verification are taught in various modules and applied through coursework components. The practical work includes modelling, design and IC layout laboratories and hands-on FPGA design, directed reading and coursework assignments, which can contain a literature review.
B4, B5: The Project Preparation module and the Individual Project itself concern the formulation of a research project. Small group teaching, including all practical work, and the individual project accommodate different learning styles. One-on-one tutorials can support full-class lectures, when required.

Assessment Methods

B1, B2, B3, B4, B5. Design skills are assessed in examination questions and in coursework. Modelling, simulation and verification form a significant aspect of the coursework in the design projects and is assessed through the delivery of documented designs (Analogue IC, Digital IC and FPGA based designs).
B4. The Project Preparation module and the dissertation from the MSc Project include a significant literature survey and have assessment criteria to reflect this specifically.
B5. The Project dissertation is centrally focussed on assessing the difference aspects of research skills.

Transferable and Generic Skills

On successful completion of this programme you will be able to:

C1. Use conventional and electronic indexing and search methods to find technical information

C2. Present technical information in written and verbal forms

C3. Work in a pair or in a small group on a given task, managing your own contribution and the overall task

C4. Work independently on a significant research project

Teaching and Learning Methods

A number of courses have a significant coursework element. This can range from design work through to presentations resulting from directed reading. The individual project includes independent research, project management and report writing.

C1-C3: Most modules include small group teaching, practical work with one or more lab partners, directed reading and coursework assignments with a literature review component. The Project Preparation module includes project management and the delivery of a project plan via a presentation. Small group teaching, including all practical work, and the individual project accommodate different learning styles. C4: The individual project includes independent research and report writing.

Assessment Methods

Coursework is generally assessed through written reports. The individual project is assessed by a dissertation of up to 15,000 words. The Project Preparation module is assessed via a literature review, as well as written and presentation versions of the project plan.

Subject Specific Practical Skills

On successful completion of this programme you will be able to:

D1. Complete Analogue and Digital IC design from schematic to layout

D2. Program FPGAs and use them in solving practical design problems

D3. Use Industry standard design packages to analyse and simulate designs

D4. Implement and synthesize digital designs in a hardware description language

Teaching and Learning Methods

D1, D2, D3, D4: These skills will be developed through coursework and project work. Most modules include practical work, ranging from electronic lab activities, hands-on practical to simulation laboratories. The individual project will involve one or more subject specific practical skills, with one-to-one training delivered by the supervisory team or technical staff.

Assessment Methods

Assessment is based on coursework in the form of laboratory reports and the MSc dissertation.

Programme Structure

The programme structure table is below:

Information about pre and co-requisites is included in individual module profiles.

Where optional modules have been specified, the following is an indicative list of available optional modules, which are subject to change each academic year. Please note in some instances modules have limited spaces available.

Part I

Structure of the joint degree programme

The programme overall consist of four semesters, of which two will be at one of the partner Universities. If students come to Southampton for their first year on the programme, they will do two taught semesters based on the MSc System on Chip programme. If students come to Southampton for their second year on the programme, they have four optional taught modules in the first semester and will then undertake an individual project in the second semester.

However students have the flexibility to select electives across the entire range of MSc programmes offered within the department, provided that modules are appropriate to Embedded Computing Systems. This is to be determined in consultation with the Programme Leader at Southampton. For example, a student may have an interest in software or web science modules and these can be taken when students meet the module pre-requisites.

Typical course content

The first year programme consists of eight taught modules, each worth 7.5 ECTS credit points (15 CATS). The second year programme consists of four taught modules, each worth 7.5 ECTS credit points (15 CATS), and an individual research project worth 30 ECTS credit points (60 CATS). The core subjects are related to Embedded Computing Systems, covering device structure, circuit operation and fabrication methods.

There is a range of optional topics, including cryptography, communications and networks, bio-related nanotechnology, microelectronic design, design automation, embedded systems and microelectromechanical systems (MEMS) allowing you to tailor the structure to suit your interests. You will also be able to develop a project within a relevant research area of the department, which will allow further exploration of a specialist area of embedded

computing systems.

Programme details

The programme offers a wide range of modules. Most of these are shared with our Master of Engineering and Master of Science programmes in Electronics. For the first year programme there are four compulsory modules in semester 1, and four optional modules can be selected in semester 2. For the second year programme four optional modules should be selected in semester 1 and there is a research project in semester 2.

It should be noted that it may not be possible to run some optional modules if the number of students registered on the module is very small. It should also be noted that optional module choice can be restricted by the University Timetable, which varies from year to year: some optional modules may clash with other optional or compulsory modules. Please be aware that many modules are shared between different cohorts; the class size depends on cohort size, which varies from year to year.

Examinations are held at the end of Semester 1 (January) and at the end of Semester 2 (May/June). Students who have successfully completed 30 or 60 ECTS (60 or 120 CATS) worth of taught material may exit with a Postgraduate Certificate or Postgraduate Diploma respectively.

The following is the normal pattern of study for a full-time student, completing the programme within 12 calendar months.

Semester 1 (first and second year students):
Four modules, including those specified as compulsory for the programme. Examinations are held in January.

Semester 2 (first year students):
Four modules, including those specified as compulsory for the programme. Examinations are held in May/June.

Semester 2 (second year students):
Individual research project

For the First Year programme (EMECS Part I), the structure, including the compulsory and optional modules for each semester, is summarised below:

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PART I, SEMESTER 1

ELEC3221 - compulsory
ELEC6236 - compulsory
ELEC6237 - compulsory
ELEC62xx - compulsory

PART I, SEMESTER 2 - select four optional modules

ELEC6214 - optional
ELEC6232 - optional
ELEC6233 - optional
ELEC6234 - optional
ELEC6235 - optional
ELEC6227 - optional
ELEC6242 - optional
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For the Second Year programme (EMECS Part II), the structure, including the available optional modules, is summarised below:

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PART II, SEMESTER 1 - select four optional modules

ELEC3221
ELEC6203
ELEC6236
ELEC6237
ELEC6243
COMP6203
COMP6204
COMP6224
COMP6226
COMP6230
COMP6245 or COMP6246 (*)

PART II, SEMESTER 2

ELEC6128 - core
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(*) It should be noted that there are two variations of Machine Learning in semester 1, COMP6245 and COMP6246. Only one of these may be taken (i.e. they are mutually exclusive). COMP6245 'Foundations' has a deeper focus on the mathematical foundations of machine learning and aims to serve as a launching point for further study. The practical parts of 'Foundations' focus on understanding how to implement machine learning techniques and understanding how those techniques work. COMP6246 'Technologies' has a technological focus, and allows students to get hands-on experience with modern machine learning techniques. Students studying 'Technologies' will be taught how to use machine learning libraries and tools, and will be expected to achieve a conceptual understanding of how the different techniques work, as well as an understanding of their advantages and disadvantages. Note that some semester 2 modules have COMP6245 or COMP6246 as a prerequisite (see the module specifications). For 'Foundations' it is assumed that students have prior knowledge of linear algebra (including matrix operations), Calculus (including partial differentiation), probability and statistics. For 'Technologies' students should be comfortable with basic linear algebra and the fundamental concepts of Calculus.

Part I Compulsory

Code	Module Title	ECTS	Type
ELEC3221	Digital IC and Systems Design	7.5	Compulsory
ELEC6236	Digital System Design	7.5	Compulsory
ELEC6256	Nanoelectronic Devices (MSc)	7.5	Compulsory
ELEC6237	Secure Hardware and Embedded Devices	7.5	Compulsory

Part I Optional

Select four semester 2 modules (22.5 ECTS/45 CATS) from the following:

Code	Module Title	ECTS	Type
ELEC6214	Advanced Wireless Communications Networks and Systems	7.5	Optional

ELEC6232	Analogue and Mixed Signal CMOS Design	7.5	Optional
ELEC6242	Cryptography	7.5	Optional
ELEC6233	Digital Systems Synthesis	7.5	Optional
ELEC6234	Embedded Processors	7.5	Optional
ELEC6227	Medical Electrical and Electronic Technologies	7.5	Optional
ELEC6235	SOC Design Project	7.5	Optional

Part II

Part II Core

Code	Module Title	ECTS	Type
ELEC6128	EMECS MSc Project 2020-21	30	Core

Part II Optional

Select four semester 1 modules (30 ECTS/60 CATS) from the following:

Code	Module Title	ECTS	Type
ELEC6243	Control System Design (MSc) 2020-21	7.5	Optional
ELEC3221	Digital IC and Systems Design 2020-21	7.5	Optional
ELEC6236	Digital System Design 2020-21	7.5	Optional
COMP6224	Foundations of Cyber Security 2020-21	7.5	Optional
COMP6245	Foundations of Machine Learning (MSc) 2020-21	7.5	Optional
COMP6203	Intelligent Agents 2020-21	7.5	Optional

COMP6246	Machine Learning Technologies (MSc) 2020-21	7.5	Optional
ELEC6203	Microsensor Technologies 2020-21	7.5	Optional
COMP6230	Network and Web Based Security 2020-21	7.5	Optional
ELEC6237	Secure Hardware and Embedded Devices 2020-21	7.5	Optional
COMP6226	Software Modelling Tools and Techniques for Critical Systems 2020-21	7.5	Optional
COMP6204	Software Project Management and Secure Development 2020-21	7.5	Optional

Progression Requirements

The programme follows the University's regulations for ***Progression, Determination and Classification of Results : Undergraduate and Integrated Masters Programmes*** and ***Progression, Determination and Classification of Results: Postgraduate Master's Programmes*** as set out in the University Calendar: http://www.calendar.soton.ac.uk/sectionIV/sectIV-index.html

Support for student learning

There are facilities and services to support your learning some of which are accessible to students across the University and some of which will be geared more particularly to students in your particular Faculty or discipline area.

The University provides:

- library resources, including e-books, on-line journals and databases, which are comprehensive and up-to-date; together with assistance from Library staff to enable you to make the best use of these resources
- high speed access to online electronic learning resources on the Internet from dedicated PC Workstations onsite and from your own devices; laptops, smartphones and tablet PCs via the Eduroam wireless network. There is a wide range of application software available from the Student Public Workstations.
- computer accounts which will connect you to a number of learning technologies for example, the Blackboard virtual learning environment (which facilitates online learning and access to specific learning resources)
- standard ICT tools such as Email, secure filestore and calendars.
- access to key information through the MySouthampton Student Mobile Portal which delivers timetables, Module information, Locations, Tutor details, Library account, bus timetables etc. while you are on the move.
- IT support through a comprehensive website, telephone and online ticketed support and a dedicated helpdesk in the Hartley Library.
- Enabling Services offering support services and resources via a triage model to access crisis management, mental health support and counselling. Support includes daily Drop In at Highfield campus at 13.00 – 15.00 (Monday, Wednesday and Friday out of term-time) or via on-line chat on weekdays from 14.00 – 16.00. Arrangements can also be made for meetings via Skype.
- assessment and support (including specialist IT support) facilities if you have a disability, long term health problem or Specific Learning Difficulty (e.g. dyslexia).
- the Student Services Centre (SSC) to assist you with a range of general enquiries including financial matters, accommodation, exams, graduation, student visas, ID cards
- Career and Employability services, advising on job search, applications, interviews, paid work, volunteering and internship opportunities and getting the most out of your extra-curricular activities alongside your degree programme when writing your CV
- Other support that includes health services (GPs), chaplaincy (for all faiths) and 'out of hours' support for students in Halls and in the local community, (18.00-08.00)
- A Centre for Language Study, providing assistance in the development of English language and study skills for non-native speakers.

The Students' Union provides

- an academic student representation system, consisting of Course Representatives, Academic Presidents, Faculty Officers and the Vice-President Education; SUSU provides training and support for all these representatives, whose role is to represent students' views to the University.
- opportunities for extracurricular activities and volunteering
- an Advice Centre offering free and confidential advice including support if you need to make an academic appeal
- Support for student peer-to-peer groups, such as Nightline.

Associated with your programme you will be able to access:

· The tutorial system – you will have a personal tutor whom you can meet on request for advice on your programme and choice of options, or for pastoral support
· The ECS Student Advisory Team who provide additional pastoral support
· ECS computer workstations, with a range of manuals and books
· Specialist project laboratories
· Personal email account and web access, including use of on-line collaboration tools
· Helpdesk (programming advisory)
· Post-graduate demonstrators who provide additional support for your design projects
· A web-site for each taught module, typically with teaching materials

Methods for evaluating the quality of teaching and learning

You will have the opportunity to have your say on the quality of the programme in the following ways:

· Completing student evaluation questionnaires for each module of the programme
· Acting as a student representative on various committees, e.g. Staff: Student Liaison Committees, Faculty Programmes Committee OR providing comments to your student representative to feedback on your behalf.
· Serving as a student representative on Faculty Scrutiny Groups for programme validation
· Taking part in programme validation meetings by joining a panel of students to meet with the Faculty Scrutiny Group

The ways in which the quality of your programme is checked, both inside and outside the University, are:

· Regular module and programme reports which are monitored by the Faculty
· Programme validation, normally every five years.
· External examiners, who produce an annual report
· Professional body accreditation/inspection
· A national Research Evaluation exercise (our research activity contributes directly to the quality of your learning experience)
· Institutional Review by the Quality Assurance Agency

Further details on the University's quality assurance processes are given in the *Quality Handbook*.

Career Opportunities

This programme provides an excellent platform for further research in either industry or academia.

Graduates from our MSc programme are employed worldwide in leading companies at the forefront of technology. ECS runs a dedicated careers hub which is affiliated with over 100 renowned companies like IBM, ARM, Microsoft Research, Imagination Technologies, Nvidia, Samsung and Google to name a few.

External Examiner(s) for the programme

Name: Professor Scott Roy - University of Glasgow

Students must not contact External Examiner(s) directly, and external examiners have been advised to refer any such communications back to the University. Students should raise any general queries about the assessment and examination process for the programme with their Course Representative, for consideration through Staff: Student Liaison Committee in the first instance, and Student representatives on Staff: Student Liaison Committees will have the opportunity to consider external examiners' reports as part of the University's quality assurance process.

External examiners do not have a direct role in determining results for individual students, and students wishing to discuss their own performance in assessment should contact their Personal Academic Tutor in the first instance.

Please note: This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided. More detailed information can be found in the programme handbook.

Appendix 1:

Students are responsible for meeting the cost of essential textbooks, and of producing such essays, assignments, laboratory reports and dissertations as are required to fulfil the academic requirements for each programme of study. In addition to this, students registered for this programme also have to pay for:

Additional Costs

Type	Details
Stationery	You will be expected to provide your own day-to-day stationary items, e.g. pens, pencils, notebooks, etc). Any specialist stationery items will be specified under the Additional Costs tab of the relevant module profile.
Textbooks	Where a module specifies core texts these should generally be available on the reserve list in the library. However due to demand, students may prefer to buy their own copies. These can be purchased from any source. Some modules suggest reading texts as optional background reading. The library may hold copies of such texts, or alternatively you may wish to purchase your own copies. Although not essential reading, you may benefit from the additional reading materials for the module.
Approved Calculators	Candidates may use calculators in the examination room only as specified by the University and as permitted by the rubric of individual examination papers. The University approved models are Casio FX570 and Casio FX-85GT Plus. These may be purchased from any source and no longer need to carry the University logo.
Printing and Photocopying Costs	In the majority of cases, coursework such as essays; projects; dissertations is likely to be submitted on line. However, there are some items where it is not possible to submit on line and students will be asked to provide a printed copy.

In some cases you'll be able to choose modules (which may have different costs associated with that module) which will change the overall cost of a programme to you. Details of such costs will be listed in the Module Profile. Please also ensure you read the section on additional costs in the University's Fees, Charges and Expenses Regulations in the University Calendar available at www.calendar.soton.ac.uk.