1. **Title of the module**

EENG8290 (EL829) - Embedded Real-Time Operating Systems

1. **School or partner institution which will be responsible for management of the module**

Engineering and Digital Arts

1. **The level of the module (Level 4, Level 5, Level 6 or Level 7)**

Level 7

1. **The number of credits and the ECTS value which the module represents**

15 credits (7.5 ECTS)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Spring

1. **Prerequisite and co-requisite modules**

None

1. **The programmes of study to which the module contributes**

MSc/PDip Embedded Systems and Instrumentation

MSc/PDip Wireless Communications & Signal Processing

MSc/PDip Advanced Electronic Systems Engineering

MEng Computer Systems Engineering (incl. with a Year in Industry variant)

MSc/PDip Embedded Communications Engineering

MSc/PDip Integrated Circuit Design Engineering

1. **The intended subject specific learning outcomes.
On successfully completing the module students will be able to:**

Have a knowledge and understanding of:

8.1 Operating systems and their advantages to embedded systems design

8.2 RTOS Basic Principles

8.3 RTOS development tools and environments

8.4 Practical RTOS systems and applications

8.5 HW/SW Co-synthesis algorithms

8.6 System partitioning for HW/SW co-design

8.7 Special HW/SW architectures

These outcomes are related to the programme learning outcomes in the appropriate curriculum maps as follows:

MSc in Embedded Systems and Instrumentation: A1,A3-A5,A7, B1-B3,B5, C1-C3,C6

MSc/PDip in Advanced Electronic Systems Engineering: A2-A4, B1-B3, B5, C1-C3, C6

MSc/PDip in Wireless Communications & Signal Processing: A6-A9, B1-3, B5, C1-3, C6

MEng in CSE/CSEwInd: A12-16, B2-B4, B10, C3, C13

1. **The intended generic learning outcomes.
On successfully completing the module students will be able to:**

9.1 Show an ability to deal with complex issues systematically and creatively and make judgements in the absence of complete data, and show that they are capable of self-direction and problem solving. (D1, D3)

9.2 Have the ability to use and understand a range of modern CAD tools and general ICT. (D2)

9.3 Demonstrate the ability to communicate complex ideas and concepts to specialist and non-specialist audiences. (D1, D7)

9.4 Show that they are capable of learning independently, use critical thinking and analysis and demonstrate autonomy in time and resource management. (D3-D6)

1. **A synopsis of the curriculum**

Embedded real time operating systems (rtos)

Operating Systems (OS) and Real-Time Operating Systems (RTOS). Embedded RTOS. Software development methods and tools: Run-time libraries. Writing a library. Porting kernels. Concurrent Programming and Concurrent Programming Constructs. Task Scheduling and Task Interaction. Basic Scheduling methods, scheduling algorithms. Tasks, threads and processes. Context switching. Multitasking. Communication, Synchronisation. Semaphores and critical sections. Example RTOS systems. (E.g. Embedded Linux, Windows CE, Micrium, VxWorks etc.). Programming and debugging Embedded Systems. Practical examples and case studies.

Hardware/software co-design

Embedded Processors; Hard and Soft Processor Macros (e.g. Altera Nios and Xilinx Microblaze, ARM). A brief overview of peripherals. Architectural Models. HW/SW Partitioning and partitioning algorithms. Distributed systems. Memory architectures, architectures for control-dominated systems. Architectures for data-dominated systems. Compilation techniques for embedded processor architectures. Modern embedded architectures. Architecture examples in multimedia, wireless and telecommunications. Examples of emerging architectures. Multiprocessor and multicore systems.

1. **Reading list (Indicative list, current at time of publication. Reading lists will be published annually)**
* Amos, D, Lesea, A and Richter, R, 2011. FPGA-Based Prototyping Methodology Manual: Best Practices in Design-for-Prototyping. S.l.: Synopsys Press. ISBN 9781617300042
* Bailey, D. G., 2011. Design for Embedded Image Processing on FPGAs. Singapore: John Wiley & Sons (Asia). ISBN 9780470828496
* Berger, A, Embedded Systems Design: An Introduction to Processes, Tools, and Techniques. Berkeley, CA: CMP Books. ISBN 9781578200733
* Bertolotti, I. C and Manduchi, G, Real-Time Embedded Systems: Open-Source Operating Systems Perspective. London: CRC. ISBN 9781439841549
* Valvano, Jonathan W., [no date]. Embedded Systems: Introduction to the Arm® Cortex(TM)-M3: ISBN 9781477508992
1. **Learning and teaching methods**

Total contact hours: 36

Private study hours: 114

Total study hours: 150

1. **Assessment methods**
	1. Main assessment methods

Practical (20%)

Practical (20%)

Examination (60%)

In order to obtain credit for this module on IET accredited programmes, the coursework mark and the exam mark must each be greater than or equal to 40% as well as achieving the pass mark for the module. This module will only be considered for compensation if the coursework mark and exam mark are each greater than 40%.

13.2 Reassessment methods

Like-for-like

1. **Map of module learning outcomes (sections 8 & 9) to learning and teaching methods (section12) and methods of assessment (section 13)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** | *8.1* | *8.2* | *8.3* | *8.4* | *8.5* | *8.6* | *8.7* | *9.1* | *9.2* | *9.3* | *9.4* |  |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |  |
| **Private Study** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** | **X** | **X** |  |
| *Lectures* | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** |  | **X** | **X** |  |
| *Workshops* |  |  |  |  | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |
| *Mini-Projects 1&2* |  |  | **X** |  | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  |
| *Examination* | **X** | **X** |  | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |  |

1. **Inclusive module design**

The School recognises and has embedded the expectations of current equality legislation, by ensuring that the module is as accessible as possible by design. Additional alternative arrangements for students with Inclusive Learning Plans (ILPs)/declared disabilities will be made on an individual basis, in consultation with the relevant policies and support services.

The inclusive practices in the guidance (see Annex B Appendix A) have been considered in order to support all students in the following areas:

a) Accessible resources and curriculum

b) Learning, teaching and assessment methods

1. **Campus(es) or centre(s) where module will be delivered**

Canterbury

1. **Internationalisation**

The design and implementation of embedded systems using modern software and hardware techniques and technologies is of international importance. Many aspects of our modern world rely on complex but reliable digital hardware working seamlessly with embedded software and real-time operating systems. Such systems are constantly evolving as technology continues to develop at a rapid pace. Consider just how many times a day we interact with a digital system and how modern digital communication technologies enables the work we do to be broadcast and disseminated to an international audience. An understanding of these core software and hardware techniques and methods used for designing such systems is essential to many engineering and design industries and services.

**DIVISIONAL SUPPORT OFFICE USE ONLY**

**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
|  |  |  |  |  |
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Revised FSO Jan 2018