

MODULE DESCRIPTOR

MODULE TITLE	Embedded Real-time Systems		
MODULE CODE	EL3243 (L6)	CREDIT VALUE	20 UK CREDITS / <u>10 ECTS</u>
SCHOOL	SCHOOL OF SCIENCES		

MODULE AIMS

- To introduce students to the real-time and concurrent systems nomenclature and methodology.
- To provide students with the theoretical and practical skills that will enable them to design, build, program and use embedded real-time systems.

MODULE CONTENT

Indicative syllabus content:

Introduction to real-time systems.

Definition of real-time processing, real-time operating systems and real-time systems; examples of real-time systems; characteristics of real-time systems, embedded real-time hardware overview, hardware/software tradeoffs, introduction to embedded real-time design.

Real-time, and concurrent programming.

Concurrent programming abstractions. Interleaving; atomic instructions; correctness.

Scheduling models.

Pre-emptive and non pre-emptive scheduling; foreground/background scheduling; software/hardware interrupts and tasks scheduling. Clock driven scheduling; round-robin scheduling; priority-driven scheduling. Scheduling of periodic tasks; scheduling aperiodic and sporadic jobs.

Synchronisation and communication between processes

Semaphores; Binary and counting semaphores; mutual exclusion semaphores; locks; deadlocks. The mutual exclusion problem; definition of mutual exclusion problem; Dekker's algorithm; mutual exclusion for N processes. The priority inversion problem; priority inheritance protocol; priority ceiling protocol. Mailboxes, queues, pipes, streams, device drivers

Real-time debugging and profiling

Non real time versus real-time analysis methodology; logging events; statistics accumulators.

"Real-time" operating systems

Time services, and scheduling mechanisms; communication and synchronisation; kernel footprint; memory management; application programming interface. Examples of commercial real-time operating systems: SYS/BIOS, RTLinux, CMSIS/RTX.

Examples of applications of real-time systems in control, signal and image processing.

INTENDED LEARNING OUTCOMES

On successful completion of this module a student will be able to:

1. Demonstrate the ability to interpret and analyse real-time and concurrency constraints imposed on systems.
2. Evaluate the characteristics of and modern trends in embedded real-time systems technology.
3. Produce design briefs, specifications and concepts for embedded real-time systems.

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4. Critically appraise the issues related to software/hardware interrupt and task scheduling models; process synchronisation and communication; real-time debugging and profiling.
 5. Design, implement and evaluate a practical embedded real-time system meeting specific requirements
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TEACHING METHODS

Lectures and directed reading provide students with the fundamental knowledge base. The laboratory sessions consolidate understanding through application. The laboratory exercises familiarise students with software & hardware development tools for real-time embedded systems and allow the students opportunity to experiment with & investigate the performance of RTOS analysis, scheduling & communication techniques.

ASSESSMENT METHODS

This module is assessed through a written examination and an assignment: design study and implementation.