Wrexham Glyndŵr University

MODULE SPECIFICATION PROFORMA

Module Title:	**Embedded Systems**	**Level**:	5	**Credit Value**:	20

Module code:	ENG53E	**Is this a new module?**	Yes	**Code of module being replaced**:	ENG52K

Cost Centre:	GAEE	**JACS3 code**:	

Trimester(s) in which to be offered:	1 & 2	**With effect from:**	September 18

School:	Faculty of Arts, Science and Technology	**Module Leader:**	Andrew Sharp

Scheduled learning and teaching hours	60 hrs
Guided independent study	140 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered	Core	Option
BEng (Hons) Electrical and Electronic Engineering	☐	✓
BEng (Hons) Drone Technology and Operations	✓	☐
BEng (Hons) Optoelectronics and Holography	✓	☐

Pre-requisites
None

Office use only
Initial approval February 17
APSC approval of modification Sept 18 Version 1
Have any derogations received Academic Board approval? Yes ✓ No ☐

Module Aims
1. Demonstrate knowledge and awareness of microprocessor capabilities both as the central processing element in a computer system and as an embedded element in an electronic system. 2. To provide a knowledge of the programming languages and the software used for programming microcontrollers. 3. How to interface microcontrollers, as part of an embedded system, to sensors and actuators for engineering applications.

Intended Learning Outcomes

Key skills for employability

KS1	Written, oral and media communication skills
KS2	Leadership, team working and networking skills
KS3	Opportunity, creativity and problem solving skills
KS4	Information technology skills and digital literacy
KS5	Information management skills
KS6	Research skills
KS7	Intercultural and sustainability skills
KS8	Career management skills
KS9	Learning to learn (managing personal and professional development, self-management)
KS10	Numeracy

	At the end of this module, students will be able to	Key Skills	
1	Demonstrate knowledge of microprocessor capabilities both as the central processing element in a computer system and as an embedded element in an electronic system	KS4	
2	Apply a systematic approach to design embedded systems to address the application needs, and develop the basic knowledge and skills to build, debug, test, evaluate and embedded systems; Design appropriate hardware interfacing	KS3	
3	Write, test and evaluate computer language programs for engineering applications	KS3	
		KS4	

Transferable/key skills and other attributes

1. System analysis and design;
2. Apply design
3. Apply Technology

Derogations

A derogation from regulations has been approved for this programme which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%.

Assessment:

Assessment is by means of producing a portfolio of evidence gathered throughout the duration of the course demonstrating a knowledge of embedded systems and their application in engineering situations.

Such evidence may include writing a correctly documented and structured microcontroller programme to enable a microprocessor to respond to inputs and control outputs to external hardware.

For example designing an algorithm and using a suitable programming language to write clearly commented code plus designing an interface to connect the microcontroller to external hardware such as sensors and actuators.

The assessment should also give the student the opportunity to provide evidence of underpinning knowledge such as digital logic operations, transducers and computer architecture.

The portfolio will cover all learning outcomes.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	1,2,3	Portfolio	100		4000

Learning and Teaching Strategies:

This module will be presented to the students through a series of lectures, tutorials, practical lab work and ECAD investigations.

Learning materials will include in-class and on-line lecture notes, exercises and tutorials.

Access to practical Laboratory facilities and ECAD will be available to students. It is preferred that students study both the hardware and software elements in parallel, throughout the year, so that students are exposed the programming elements of embedded systems while considering the challenges of interfacing to external hardware.

Analysis of embedded system design problems and development of problem statements. Systematic and integrated embeded system design.

Extensive use will be made of VLE (Moodle) to supplement learning materials

Syllabus outline:
Digital conventions: Bit, byte, word; binary, hexadecimal, octal; binary arithmetic, logical operations; Gray code, BCD, ASCII. **System architecture:** Clock, CPU, memory, interfaces, bus systems and controlling logic; CPU internal architecture; Van Neumann model - fetch/execute cycle; instruction set, timing. Pipeline and multi-processing architectures. **Memory structures:** Main memory address, access and structures; device types and parameters, memory map. **Interfaces:** Functional treatment of parallel ports, serial ports - UARTs etc, ADC/DACs. Dedicated interfaces e.g. to drive 'power' equipment. Memory-mapped I/O and I/O mapping. Communication: polling and interrupts. Bus systems e.g. VME, STE, I^2C. **Design, writing and testing:** of assembly language programs for a microcontroller (eg PIC) or a personal computer processor. Development tools (editor, assembler, ICE), use of subroutines, functions, to carry out an engineering task. **Digital system design process**: Combinational simplification: tabular method. Sequential system design and analysis for components and circuits. **D/A and A/D conversions** **Introduction to FPGA/CPLD:** **Hardware description language (HDL)**: VHDL or Verilog basic concepts **Hardware:** structural description, behavioural description, design organisation and Parameterisation. **Practical examples:** Systematic methods on digital systems design. **Practical/IT session includes:** comparison types of FPGA/CPLD, introduction to coding practices, working towards digital system design.

Bibliography:
Essential reading
Bates, M. (2011) *The PIC Microcontroller: An Introduction to Microelectronics*, 3rd Edn, Newnes.
Other indicative reading
Kafig, W. (2011) *VHDL 101: Everything you Need to Know to Get Started*, Newnes. Hughes, E. et al. (2012) *Electrical and Electronic Technology*, 11th Edn., Pearson. Wakerly, J.F. (2005) *Digital Design: Principles and Practices*, 4th Edn., Prentice-Hall.