Module Definition Form (MDF)

Module code: MOD009722	**Version:** 2 **Date Amended:** 13/Jun/2024

1. Module Title
Electronics and Embedded Systems

2a. Module Leader
Alireza Sanaei

2b. School
School of Engineering and the Built Environment

2c. Faculty
Faculty of Science and Engineering

3a. Level
4

3b. Module Type
Standard (fine graded)

4a. Credits
30

4b. Study Hours
300

5. Restrictions

Type	Module Code	Module Name	Condition
Pre-requisites:	None		
Co-requisites:	None		
Exclusions:	None		
Courses to which this module is restricted:			

LEARNING, TEACHING AND ASSESSMENT INFORMATION

6a. Module Description

This module introduces you to the fundamental principles of both analogue and digital electronic circuits and provides the foundation for analysis and design in industry. The module begins with the fundamentals of analogue components including resistors, capacitors and inductors, and shows how simple circuits are designed using these components. It introduces various forms of diodes, transistors and operational amplifiers and explains their equivalent circuit models. It also introduces the measurement and analysis tools used in the electronics industry. The operating principles of all circuit elements are covered by lectures and tutorials, supplemented by practical experiments using both hardware and circuit simulation software. This enables you to compare actual measured results with theory as well as illustrating the effects of component tolerances. The practical work will also give you the experience of the presentation and interpretation of manufacturers' data for real components helping you to explore the limitations of laboratory techniques and instruments.

Next, digital devices and the fundamentals of Boolean logic are examined. The different logic gates are explained. Techniques are introduced for generating and simplifying logical expressions using Boolean algebra and Karnaugh maps. Practical applications are examined, including the design of fundamental circuits such as decoders, encoders and arithmetic circuits. This is followed by examining how sequential logic techniques allow us to design circuits with memory. Different types of memory are explained, along with their applications.

The module also focuses on the design and operational characteristics and internal architecture of Embedded Systems. It examines the programming techniques that can be applied to real time systems using different programming languages such as C programming and Ladder Logic. The unit also provides you with Workshop and laboratory skills. You will be given the opportunity to develop Real Time embedded Operating system on dedicated hardware platforms (such us PLC) in order to solve given engineering problems (for example produce a programme for an engineering application, store, evaluate and justify approaches taken). This module forms the basis of embedded controllers for electrical machines, and it is a key development of workplace practice and employment. You will investigate how to design embedded systems for monitoring inputs and changes outputs using specialised software (such as Siemens Ladder logic and Microchip MPLAB IDE). The created program can include Boolean logic, counting, timing, complex math operations, and communications with other devices such as wireless GSM or WIFI modules. This unit will introduce you to the principles of microprocessors and give you experience of using and programming a microprocessor system for the operation or control of peripheral devices. This unit will provide an introduction to the terminology (e.g. bits, bytes, words) and concepts related to microprocessor applications. The unit will also develop your understanding of the architecture and operation of real time embedded microprocessor-based systems and the use of decimal, binary and hexadecimal number systems, and functions for programming. Successful completion of this module will provide a range of knowledge and skills of value to employers with an interest in microprocessors programming.

6b. Outline Content

- Introduction to laboratory instruments

- Review of DC circuit theory

- Reactance

- Resonance

- Filters

- Diodes (physics, types and applications)

- Operational amplifiers

- Bipolar transistors (physics and analysis)

- Introduction to other commonly used components

- Introduction to analogue transducers

- Boolean algebra (truth tables, gates, axioms, De Morgan's theorem)

- Logic families (TTL, CMOS, ECL)

- Combinational logic (SOP's, POS's, Karnaugh maps)

- Number systems (binary, octal, denary, hexadecimal), representations of negative numbers

- Arithmetic circuits (adders, subtractors, overflow)

- Decoders and encoders

- Sequential logic (SR, D, JK memory elements), counters

- Instrument specification, errors

- Circuit simulation software

- Overview of Embedded Systems architecture

- Development and Testing of Real time Software for Embedded Controllers and PLCs

6c. Key Texts/Literature

The reading list to support this module is available at: https://readinglists.aru.ac.uk/

6d. Specialist Learning Resources

Electronics laboratory with components and test equipment.

PC laboratory with circuit simulation software

PLC programming software Siemens PLC Programming Software 4.0, for use with SIMATIC S7-200 Programmable Logic Controller Siemens S2-700 PLC Input and Output devices & wireless embedded microprocessor-based module MX20

7. Learning Outcomes (threshold standards)		
No.	**Type**	**On successful completion of this module the student will be expected to be able to:**
1	Knowledge and Understanding	Understand the fundamentals of analogue & digital electronic building blocks, circuit theory, and wider applications and trends in the topic.
2	Knowledge and Understanding	Understand the design and operational characteristics of an embedded system.
3	Intellectual, practical, affective and transferrable skills	Use the theory to analyse and design analogue and digital electronic circuits.
4	Intellectual, practical, affective and transferrable skills	Apply an integrated or systems approach to the solution of electronic problems related to embedded systems.
5	Intellectual, practical, affective and transferrable skills	Conduct practical experiments to investigate and analyse complex problems in analogue and digital systems and embedded systems.
6	Intellectual, practical, affective and transferrable skills	Appreciate the implications of the tolerances of practical component values.

8a. Module Occurrence to which this MDF Refers				
Year	**Occurrence**	**Period**	**Location**	**Mode of Delivery**
2025/6	ZZF	Template For Face To Face Learning Delivery		Face to Face

8b. Learning Activities for the above Module Occurrence			
Learning Activities	**Hours**	**Learning Outcomes**	**Details of Duration, frequency and other comments**
Lectures	24	1-4	2 hours lecture x 12 weeks
Other teacher managed learning	48	5-6	4 hours lab x 12 weeks
Student managed learning	228	1-6	Self-directed learning
TOTAL:	300		

9. Assessment for the above Module Occurrence					
Assessment No.	**Assessment Method**	**Learning Outcomes**	**Weighting (%)**	**Fine Grade or Pass/Fail**	**Qualifying Mark (%)**
010	Coursework	3-6	50 (%)	Fine Grade	30 (%)
Coursework (3000 words) maps to Engineering Council Learning Outcome C1, C10, C12					

Assessment components for Element 010				
Component No.	**Assessment Title**	**Submission Method**	**Weighting (%)**	**Components needed for Mark Calculation?**
010/1	Electronics Coursework 1500 words (LO3,5,6 maps to C1, C12)	Canvas	50 (%)	All
010/2	Embedded Systems Coursework 1500 words (LO4,5 maps to C10, C12)	Canvas	50 (%)	

Assessment No.	**Assessment Method**	**Learning Outcomes**	**Weighting (%)**	**Fine Grade or Pass/Fail**	**Qualifying Mark (%)**
011	Examination Chelmsford	1-4	25 (%)	Fine Grade	30 (%)
1.5 hour Electronics Exam (LO1,3 maps to C1)					
Assessment No.	**Assessment Method**	**Learning Outcomes**	**Weighting (%)**	**Fine Grade or Pass/Fail**	**Qualifying Mark (%)**
012	Examination Chelmsford	1-4	25 (%)	Fine Grade	30 (%)
1.5 hour Embedded Systems Exam (LO2,4 maps to C6)					

In order to pass this module, students are required to achieve an overall mark of 40% (for modules at levels 3, 4, 5 and 6) or 50% (for modules at level 7*).

In addition, students are required to:
(a) achieve the qualifying mark for each element of fine graded assessment as specified above
(b) pass any pass/fail elements

[* the pass mark of 50% applies for all module occurrences from the academic year 2024/25 – see Section 3a of this MDF to check the level of the module and Section 8a of this MDF to check the academic year]