Module Type		Taught		
Level		5	Credit Value	20
Programme(s) in which module is available		BEng: Electrical and Electronic Engineering; Communication Engineering; Electronic Engineering and Computer Science. BSc: Internet Systems		
Involvement of Other Schools		None		
Resource Split		N/A		
Name of Module Co-ordinators		Dr GF Carpenter; Dr DJ Holding		
Related Modules	Pre-requisites	EE1ESE; EE1DAE or equivalent		
	Co-requisites	None		
	Prohibited Combinations	None		
Minimum and Maximum Intake Sizes		None		

Aims of the Module

- To provide students with a sound understanding of the structured design of digital electronic logic circuits and systems and their implementation as application-specific logic circuits. *Students will be exposed to the principles of sequential logic design and implementation using traditional (schematic-based) and hardware description language (HDL) based approaches. They will learn methods for systematically designing sequential circuits that satisfy their functional specifications using state-of-the-art ECAD facilities and design flows. Theoretical knowledge will be complemented by implementation skills gained through a design case study involving laboratory experience in the design, simulation and synthesis of a relatively simple system and its implementation as an FPGA circuit.*
- To provide an introduction to small programmable system architecture, its operation, and techniques for programming using assembly language and higher level languages. To provide an insight into the systematic design of micro-controller and microprocessor-based programmable electronic systems. *The students will be exposed to the alternative approach in which a design is implemented as applications specific software running on an embedded microprocessor or microcontroller. As a result the student should understand how a modern RISC-based micro-controller functions, be able to specify and design software for the micro-controller, and appreciate the methods used to design micro-controller-based systems, including the techniques required to interface memory and peripheral circuits correctly.*

Summary of Content

- *Combinational Logic.* Review of the design and implementation of combinational logic and arithmetic functions; HDL representation and hardware synthesis.
- *Sequential Logic*. Specification and modelling of sequential systems: Mealy & Moore models, finite state machines (FSM's), the Algorithmic State Machine (ASM) design method. The role of simulation, functional simulation, timing simulation, verification. Design implementation using traditional (schematic diagram) techniques. HDL representation and synthesis of sequential logic including FSMs.
- *Implementation*. Typical design flows from high level models to circuit implementation, structured design methods and convergent designs. Implementation technologies, including FPLAs.
- *Register and Register Transfers*. Datapaths and data flow control. Registers and register manipulations. Register transfer operations including data bus oriented systems. Register transfer notations. HDL representation. Control of register transfers. Modularity and Compositionality, the building blocks of programmable architectures.
- *Microprocessors and Microcontrollers.* Computer systems architecture. The instruction cycle of the classical microprocessor. The structure and operation of modern RISC-based micro-controllers (AVR and C167).
- *Assembly Language and simple programs*: data declaration; program structures; program flow control; input-output; stacks; subprograms
- *Review of architecture*. Bus structures. Memory; its structure and operation; the memory interface: its specification, address decoding, timing diagrams, bus read and write cycles. The peripheral interface (Serial, parallel, ADC, DAC). Interrupts. Timers.

Summary of Methods and Frequency of Teaching

Lectures/tutorials: 40 hours
Laboratory: Two design case studies each with 15 hrs scheduled supervised contact per student:
Private study: 130 hours

Summary of Methods of Assessment and Feedback (including formative feedback)

Formal written examination (60%)

Continuous assessment, including two case studies (20% each): programmable electronic systems; design and implementation of an application specific logic circuit.

Feedback will be provided according to School guidelines. 1-to-1 feedback will be provided orally in the laboratory, in presentations and demonstrations, and by written comments on written reports. Generic feedback will be provided orally in class and via Blackboard.

Module Outcomes – what the student should gain from successful completion of the module:	Learning and Teaching and Assessment Strategies to enable outcomes to be achieved and demonstrated	
	Learning and Teaching Methods	Assessment Methods
Knowledge and Understanding of • Fundamental concepts & principles of structured design of digital electronic logic circuits and systems, and programmable electronic systems. • Design and implementation techniques applicable to application-specific digital systems design, and programmable electronic systems design. • The use of professional electronic CAD environments to characterise system performance	Lectures, recommended reading, design case studies, tutorial problems, simulation	Examination and design case studies
Intellectual Skills • Analyse and solve engineering problems • Evaluate and integrate information from a variety of sources • Plan, conduct, evaluate and report on a programme of work. • Design a solution to an engineering problem, subject to various constraints, evaluate that design and make improvements	Lectures, recommended reading, design case studies, tutorial problems, simulation	Examination and design case studies
Professional/Subject Specific Skills • Plan and execute safely a series of measurements • Use professional software and hardware development environment • Prepare a technical report or presentation • Write computer programs	Design case studies, tutorial problems	Design case studies and examination
Transferable Skills • The ability to communicate effectively, both in writing and orally • The ability to solve problems • The ability to model engineering solutions • The ability to carry out self study • The ability to use ICT • The ability to manage time and resources • Independent learning skills to facilitate professional development	Lectures, laboratory exercises, design case studies, tutorial problems	Design case studies and examination

Introductory Learning Resources	Module information, tutorial material and generic feedback will be available on Blackboard
Core Texts	Logic and Computer Design Fundamentals., Mano, M.M. and Kime, C.R., 4th Ed., Pearson Prentice Hall, 2008. ISBN 013198926X AVR & C167 RISC-based micro-controller information from on-line resources.
Reading Lists	'Digital Design: (International Version), Principles and Practice Package', Wakerly, J.F., 4th Edn , Prentice Hall 2005. ISBN 0131733494.. Contemporary Logic Design, Katz, R.H. and Borriello, G., 3rd Ed., Prentice Hall, 2005. ISBN 0131278304 Contemporary Logic Design and VHDL a Starter's Guide', Katz, R.H. and Yalamanchili, S., 3rd Ed., Prentice Hall, 2005, ISBN 1405824980 The Designers Guide to VHDL (Systems on Silicon)', Ashenden, P.J. 2nd Ed., Morgan Kauffmann, 2007. ISBN 1558606742
Specification completed by: Date	Geof Carpenter 27.7.09