ELECTRONIC ENGINEERING 1Y

Course code	7LRU
GU Credits	20
ECTS Credits	10
Corequisite course	Electronic Engineering 1X (7LPU)
Teaching staff (the first has overall responsibility)	Prof J H Davies (telephone 4115; email J.Davies) Prof J M R Weaver (telephone 5656; email J.Weaver)
Approximate size of class	100 students
Semester	2

Description of course

1. Digital Electronics

24 lectures and tutorials

Aims

To introduce basic concepts of synchronous and asynchronous digital electronics, illustrated with systems based on flip-flops and a small, modern microcontroller.

Objectives

Understand operation of basic types of flip-flop (*SR*, *D*, *T*, *JK*), effect of control inputs, recognise types of clocking, know how to use transition tables.

Design one type of flip-flop from another type using transition tables.

Know existence of propagation delay and its impact on asynchronous and synchronous circuits, draw waveforms for simple, clocked circuits.

Describe operation of ripple counters, effect of propagation delay and why this leads to unwanted states; design reset circuit to produce ripple counter with arbitrary range.

Distinguish between synchronous and asynchronous counters, waveforms in each.

Design synchronous counters using state transition table for simple up and down counters, based on *D* flip-flops; recognise structure of Moore state machine.

Design counters with arbitrary sequences using either a simple counter and decoding or a fully synchronous approach.

Know operation of shift register and simple applications, including conversion between serial and parallel data, and generation of pseudo-random sequences.

Understand concept of embedded systems and give examples; describe a microcontroller (MCU), how it differs from a microprocessor, how memory is organised, and different architectures in common use.

Explain basic architecture of Freescale MC9S08GB60, including arithmetic logic unit, program memory, data memory, input/output ports, analog–digital converter, and clock generator.

Identify regions of memory map, which are volatile and non-volatile; understand significance of memory-mapped input and output.

Understand process of writing a program in assembly language and how it is converted to binary machine code.

Know how to configure general operation of MCU and its ports, initialize the MCU, and construct the outline of a program.

Know how to connect LEDs and pushbuttons to the ports; calculate the value of series resistors and explain the need for pullups.
Write programs that use a subset of the instruction set of the MCU (only direct addressing) to drive LEDs, read pushbuttons, move and modify data, carry out basic logic and arithmetic operations, perform infinite and finite loops and tests.
Know significance of flags in condition code register and their use to control branches.
Understand how an analog input is converted to a digital value by successive approximation; know how to control the converter.

2. Digital Laboratory

6 sessions of 3 hours; the first hour will be treated as a tutorial session.

Aims
To give practical experience of designing, building and testing digital circuits, both with small-scale integrated circuit and with a development kit for a simple microcontroller. To develop skills in systematic design and documentation.

Objectives
Demonstrate operation of simple flip-flops.
Build asynchronous binary and decade counters.
Use state transition table to design and build synchronous binary and decade counters.
Gain familiarity with Metrowerks Codewarrior development environment.
Write simple programs for a Freescale MC9S08GB60 MCU using an editor, assemble them, simulate them both stand-alone and in-circuit, and download programs into the MCU.
Write and test programs to light LEDs and read pushbuttons.
Design, program and test a simple electronic dice.

Microcontroller starter kit
Students who wish to experiment with the microcontroller outside timetabled laboratories will be able to purchase a Softec PK-HCS08GB60 starter kit for the Freescale MC9S08GB60 at a subsidized price.

3. Analogue Electronics

24 lectures and tutorials

Aims
To apply the basics concepts of analogue electronics to practical circuits such as *RC* filters and amplifiers, based both on integrated operational amplifiers and transistors.

Objectives
Know impedance of resistor, inductor and capacitor and how to analyse simple a.c. circuits.
Explain operation of low pass and high pass *RC* and *RL* filters qualitatively and mathematically; define half-power point in amplitude and phase.
Design such filters to have given characteristics and cutoff frequency.
Derive differential equation for *RC* and *RL* circuits, deduce exponential solutions; explain form of solution and significance of time constant physically.
Explain what is meant by an amplifier and describe effect of source and load resistances.
Use standard model of voltage amplifier, calculate power gain, treat cascaded amplifiers.
Describe characteristics of an operational amplifier, explain assumptions of an ideal operational amplifier and how these are reflected in the behaviour of circuits.
Write down and analyse voltage follower and inverting amplifier; explain concept of virtual earth; analyse noninverting amplifier.
Use modular approach to design more compicated circuits, such as amplifiers with specified frequency response; adder; difference amplifier.

Explain what is meant by an ideal diode and how it differs from more realistic characteristics; analyse circuits by assuming states and checking for consistency; use constant voltage drop model.
Describe simple model of operation for a bipolar transistor.

4. Analogue Laboratory

6 sessions of 3 hours; the first hour will be treated as a tutorial session.

Aims
To give practical experience of designing, building and measuring analog circuits based on operational amplifiers. To develop report writing skills.

Objectives
Use basic test equipment: meters, signal generator and oscilloscope.
Design and analyse simple circuits using SPICE.
Construct and test simple analog circuits on a printed circuit board.
Maintain an adequate laboratory record.
Analyse frequency response of a tone control circuit.
Design a microphone amplifier with rectifier and low-pass filter; interface this to the microcontroller demonstration board to make a sound level meter.

Recommended books

Authors	Title, edition	Publisher	Year	ISBN	Cost	Code
A R Hambley	Electrical Engineering (3 ed)	Prentice Hall	2005	0131277642	£44	B
C Maxfield	Bebop to the Boolean Boogie (2 ed)	Newnes	2003	0750675438	£31	B
D I Crecraft, D A Gorham and J J Sparkes	Electronics (2 ed; but the first edition is better)	Nelson Thornes	2002	0748770364	£22	C
J W Nilsson and S A Riedel	Electric Circuits (7 ed)	Prentice Hall	2005	013127760X	£47	C
J R Gibson	Electronic Logic Circuits (3 ed)	Arnold	1993	0340543779	£18	C
T L Floyd	Digital Fundamentals (9 ed)	Prentice Hall	2006	0131972553	£45	C

Codes: A = compulsory; B = strongly recommended; C = recommended; D = wider reading

Study times

Type	Hours
Lectures and class tutorials	50
Laboratories	40
Tutorial sheets	40
Review and consolidation of course material	40
Revision and examinations	30

These times are a rough estimate of the work required by a typical student. There will be variations between individuals, but you will run the risk of failure if you spend significantly less time on this course than these guidelines suggest.

Assessment

Requirements for the award of credits

To ensure that a student will be awarded the credits for a course, he or she must complete the course and reach a minimum level of attainment. This requires that a student:

- be present at lectures, laboratories and tutorials on at least 50% of occasions at which attendance is monitored
- complete at least 50% of the milestones set out in the analogue and digital laboratories
- attend the class test and gain a nonzero mark
- attend the degree examination and gain a nonzero mark

Note that these are minimum requirements: good students will achieve far higher participation rates. Any student who misses an assessment or a significant number of classes because of illness or other good cause should report this. Students in the Department of Electronics and Electrical Engineering should complete a ‘Certificate of Absence’, which can be obtained from the departmental office in room 720 of the Rankine Building. Other students must follow their department or faculty’s usual procedures – we should be informed automatically.

Components of assessment

%	Type	Details
15	Class test	One test during a lecture period
15	Laboratories	Achievement of milestones and laboratory book
70	Degree examination	2 hours, all questions compulsory

The degree examinations are held in week 27 onwards; a resit is available in August.