SCHOOL OF ELECTRICAL ENGINEERING AND TELECOMMUNICATIONS
ELEC2142: Embedded Systems Design
S2 - 2010

1 Course Staff and Consultation

<table>
<thead>
<tr>
<th>Course convenor/Lecturer</th>
<th>EE Rm 207</th>
<th><a href="mailto:t.hamilton@unsw.edu.au">t.hamilton@unsw.edu.au</a></th>
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<tbody>
<tr>
<td>Dr Tara Julia Hamilton</td>
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<tr>
<th>Tutorials</th>
<th>EE Rm 404</th>
<th><a href="mailto:nonie@unsw.edu.au">nonie@unsw.edu.au</a></th>
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<td>Nonie Politi</td>
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<tr>
<th>Laboratory teaching staff</th>
<th>Matthew Conolly</th>
<th>Fergal Cotter</th>
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<tr>
<td>Gough Liu</td>
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<tr>
<td>Adrian Ratter</td>
<td>David Ma</td>
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Consultation time for this subject will be Thursday 11am-1pm or by appointment.
Consultation via email is also possible. I will try to respond as speedily as possible!

2 Course Details

Elec2142 is a 6 UOC course.

Teaching Methods

Lectures = 3hr/week; Tutorials = 1hr/week; Labs = 2hrs/week

Lectures, Tutorials and Laboratories

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<tr>
<th>Lecture (all)</th>
<th>Tue 10-12</th>
<th>Thurs 10-11</th>
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<tr>
<td>Tutorial</td>
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<td>Advanced</td>
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<td>Laboratory (only one)</td>
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Tutorial classes officially start in Week 2, and conclude in Week 13.
Laboratory classes officially start in Week 2 and conclude in Week 13. Week 2 will be used for laboratory orientation and administration, as may be used for starting the laboratory exercises.
3 Course Overview

Embedded Systems Design is intended to provide students with a firm foundation in the design and understanding of dedicated systems, to which a microprocessor or microcontroller is central and embedded within. ELEC2142 will follow on from ELEC2141 (Digital Circuit Design) and the computing subjects COMP1911/1921, and will act as a pre-requisite for further courses involving embedded microprocessor applications and design, including ELEC4601 (Digital and Embedded Systems Design) and ELEC4633 (Real-Time Engineering).

Assumed Knowledge

The subject is built upon the first course in digital circuits, ELEC2141 as well as COMP1911/1921. Assumed knowledge includes the analysis and design of sequential and combinational circuits, HDL programming and use, C language programming and use.

4 Course Objectives

The objective of this course is to equip students with the necessary fundamental knowledge and skills to design and analyse basic embedded systems, where a microprocessor or microcontroller is the central element. Such embedded systems are pervasive in all areas of society today, and as such, knowledge of how to design them is a vital skill for all electrical engineers.

The course aims to give students fundamental knowledge of embedded systems with respect to several different levels of abstraction, from a low level dealing with hardware interaction and driving the processor via assembly language, through to high level software design, multitasking, and programming with the C language, plus much in the middle.

5 Learning Objectives

The aim of this subject is to generally provide you with an understanding and an appreciation of the fundamentals of embedded systems. To this end, at the successful completion of this course, you should be able to:

- demonstrate an understanding of what an embedded system is, and what its main components are;
- demonstrate the principles of “good” software design;
- demonstrate competency in working with, and manipulating, number systems;
- demonstrate the fundamentals of assembly language programming, as well as a competency in using the C programming language for embedded applications;
• demonstrate an understanding of how a CPU operates, in particular the ARM processor;

• demonstrate an understanding of the principles in converting high level code to low level instructions;

• demonstrate an understanding of what “real-time” is in relation to embedded systems, and why “real-time” is important;

• use a mix of C and assembly to design simple embedded systems which involve the use of interrupts, multitasking, and I/O.

6 Graduate Attributes

Graduate attributes are those which the University and/or Faculty of Engineering agrees students should develop during their degree. Further information can be obtained in the document, http://www.ltu.unsw.edu.au/content/userDocs/GradAttrEng.pdf. This course aims to contribute to students attaining the following graduate attributes:

The skills involved in scholarly enquiry.

Information literacy - the skills to appropriately locate, evaluate and use relevant information. The laboratory program will require students locate/source/understand appropriate information and data sheets for the execution of the lab exercises.

The ability to engage in independent and reflective learning.

This ability is encouraged in the use of the assignment(s).

The capacity for enterprise, initiative and creativity. The laboratory program provides many challenging problems which require students to exhibit initiative and creativity in order to solve.

The capacity for analytical and critical thinking and for creative problem-solving. Labs and the assignment(s) will require students to analyse and apply supplied tools appropriately in solving challenging problems.

7 Teaching Strategies

The strategies employed in this course are focused on problem-based learning. It is intended that at each section of the course, examples of real embedded systems (or smaller parts of embedded systems) will be introduced as a way of explaining concepts. The analysis and design for each example will lend itself in assisting students to satisfy the learning objectives above. The lab program aims to support the lecture program, and provides the student with hands-on design and hardware experience. The laboratory program is challenging, and lab sessions are relatively short. As such, students MUST come prepared for each laboratory.
Students will be required to do home-based work, which will include tutorial questions, directly related to course material covered in lectures, as well as an assignment(s) to be completed and handed in during session for assessment.

8 Assessment

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<th>Component</th>
<th>Weight</th>
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<tr>
<td>Final Examination</td>
<td>70%</td>
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<tr>
<td>Assignment(s) (1 or 2)</td>
<td>10%</td>
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<tr>
<td>Laboratory Component: Laboratory Checkpoints</td>
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**Final Examination** The final examination will be a 2 hour, closed book exam dealing with material from the lectures and from the supporting laboratory program. The aim of the examination questions will be to specifically address one, or more, of the learning outcomes stated above.

**Assignment(s)** There will be one (or two) assignment(s) given during the session. Details of this will be given in Week 7. The aim of the assignment(s) will be to address a number of the learning outcomes stated above.

**Laboratory Component** Laboratory work commences in Week 2 and all experiments are done in Room 233. Each person will carry out a series of laboratory experiments. With sufficient preparation, each experiment will be nominally two hours in duration. Further details can be found in laboratory handouts which will be made available.

Each lab exercise has a series of checkpoints associated with it. Lab demonstrators and markers will be available to mark each lab checkpoint as it is successfully completed AND understood. Laboratory work is an essential component of this subject. **A pass (10/20) in the laboratory component is necessary to pass this subject.**

**Assessment submission guidelines**

Failure to submit the assignment(s) will attract a 50% penalty per day late. That is, no marks will be awarded if an assignment is submitted more than one day late. **Special consideration MUST be applied for in exceptional circumstances, and MUST be supported by appropriate documentation.**

It is hoped that assignment submissions will be marked and returned within 1-2 week of the due date.

9 Syllabus

**Introduction** What is an embedded system? Components. Structure.

**Revision (brief)** C programming language. Data representation. Number Systems.

**Computer Organisation** CPU. Memory. I/O. Addressing modes. Registers. Stack.

**Input/Output Programming** I/O addressing. Simple I/O devices. Serial/Parallel I/O. I/O synchronisation.

**Interrupts and Real-Time Systems** Concept of “time is important”. What is real-time? Foreground/background systems. Interrupt handlers. Event handling. Interrupt-driven I/O. Multitasking.

### 10 Recommended Textbooks and Reading Material

Following is a collection of useful references for this subject. The course will not be closely following any one text, but will make use of parts of each text.


Addition reference material:

- There are many suitable texts on the C programming language to choose from.
- All lecture notes/slides, labs, tutorials and their solutions, and any supplementary material will be posted on Blackboard.

### 11 Blackboard

All materials available in electronic format, will be available in Blackboard: http://lms-blackboard.telt.unsw.edu.au/webapps/portal/frameset.jsp

It is encouraged that students seeking advice/help on matters related to the course material seek help from other students, either in person, or via the discussion board in Blackboard.

Note: The discussion board is not to be used as a chat forum for subject matter not related to the subject.
Appendix on Laboratory Notebooks

According to Barrett [Barrett et.al. 2005], "Lab notebooks are used to record the process of scientific discovery, project evolution, design rationale, steps in engineering analysis, procedures followed, and raw data collected. ... Furthermore, a carefully maintained notebook allows for adequate reconstruction of original work years from the original entry ...".

Barrett also offers some guidelines that should be followed in maintaining a "good" lab book. The following points are based on the guidelines.

1. Ensure the book is bound so that individual pages cannot be lost or removed. By the same token, do not record material on loose sheets of paper, unless they are properly bound.

2. Make sure all entries are sequential in chronological order. Do not mix up recorded lab material with lecture or tutorial (or other) notes.

3. Ensure that the material is recorded in a legible fashion, so that others can read it and use it to reconstruct your experiment.

4. Number pages sequentially.

5. Do not obliterate error, cross them out with a single line.

Importantly, the lab notebooks should NOT be written as formal lab reports where much of the elements in the quote above are not included.

Reference

Appendix on Plagiarism

The following is an official, now mandatory inclusion in all UNSW course handouts.

"Plagiarism is the presentation of the thoughts or work of another as one’s own. 1 Examples include:

- direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement
- paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed. 2

Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.

"The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

"Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

"The Learning Centre website is the central University online resource for staff and student information on plagiarism

1 Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle.
2 Adapted with kind permission from the University of Melbourne.
and academic honesty. It can be located at:
www.lc.unsw.edu.au/plagiarism
The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre. “Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.