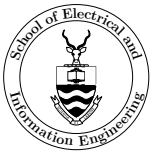

School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN2006 – Microprocessors

Course Brief and Outline: 2014

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1 Course Background and Purpose

Microprocessors are an incredibly versatile and valuable electrical engineering tool: theoretically they present the convergence of code and hardware in a single package. Microprocessors are an incredibly powerful component in the hands of a skilled designer. This course aims to equip the student with the theoretical knowledge and practical experience required to implement microprocessors and digital components in an engineering context. The course will present binary arithmetic, assembly level coding, processing schemes, microcontroller components, and the design of simple embedded systems.

2 Course Outcomes

To successfully complete this course the student must be able to:

- Program industry standard microprocessor chips at the assembly level given access to relevant documentation or software.
- Design basic hardware and assembly level code for simple microprocessor based fixed point and floating point digital algorithms.
- Implement Digital Signal Processing (DSP) type functions in general purpose microprocessors.
- Test and analyse assembly level code in a simulator environment.
- Design basic microprocessor architectural modules using combinational logic and sequential circuits.
- Design microprocessor based Analogue to Digital converters (ADC) using Digital to Analogue Converters (DACs).
- Design basic real-time microcontroller based embedded systems using selected peripheral components.

3 Course Components

Inline with the requirements that students perform satisfactorily in all course components, the student must pass each of the following components or an outcome of *FCOM* will be recorded:

- Binary mathematics:
  - Conversion between bases.
  - Fixed point operations.
  - Floating point operations.
- Microcontroller fundamentals:
  - Architecture.
  - Memory addressing and management.
  - Processessing schemes (real time, interrupt driven).
  - Programming devices.
- Microcontroller components
  - Registers.
  - Multipliers and Dividers.
  - Analog-to-digital; and digital-to-analog converters.
  - EUSART module.
  - PWM module.
  - CPU.
- Combinational and Sequential logic
  - Decoders/Encoders.
  - Multiplexers and demultiplexers
  - Adders, comparators and multipliers.
  - Registers, shift registers and converters.

4 Prior Knowledge Assumed

This is the first formal course on micropressors in the Engineering Curriculum. Although students might come into the course with a wide range of previous experience, it is assumed that all students are computer literate, i.e. that they are familiar with the components of a desktop PC and have a basic knowledge of word processing, using a spreadsheet and using the Internet.

It is assumed that the student has an understanding of digital electronics, from the electronics course in the first semester.

5 Assessment

5.1 Components of the Assessment

See the School's document entitled "Application of Rule G.13 and calculator requirements in 2009" on the School notice board.

Laboratories	10%
Class test	15%
Project	25%
Exam	50%

In addition to Rule G.13 each component and section within each component must be passed.

5.2 Assessment Criteria

In the test and examination students will be assessed by being asked in various ways to perform the following tasks:

1. Demonstrate proficiency in binary arithmetic, fixed and floating point operations.
2. Demonstrate knowledge of the principles of microprocessor operation.
3. Design algorithms to solve DSP related problems on microprocessors.
4. Design and implement algorithms to use microprocessor peripherals.
5. Demonstrate proficiency in combinational and sequential logic problems.

5.3 Satisfactory Performance Requirement

In addition to Rule G.13 and the School's document entitled "Satisfactory performance requirements and late submission penalty policy" (see the School notice board), participation in laboratories, attendance at the practical test, and submission of the course project deliverables are necessary to meet SP requirements. This rule will be strictly applied.

Note that **under no circumstances** will repeat students be granted exemption from any component of the course.

5.4 Late Submission Penalty Policy

See the School's document entitled "Satisfactory performance requirements and late submission penalty policy" on the School notice board. Note that **both** project report **and** source code must be submitted on time – if either component is late the overall penalty will be determined based on the submission time of the *last* component.

5.5 Calculators in examinations

See the School's document entitled "Application of Rule G13 and calculator requirements in 2009" on the School notice board.

6 Teaching and Learning Process

6.1 Lectures

There are three 45-minute lectures per week as shown on the student's timetable.

Although University rules state that attendance at lectures is not compulsory, lectures will be used to cover material not included in course notes. The final examination will assume that students are familiar with all material covered in the notes, in the laboratories and during lecture periods. Lecture periods will also sometimes be used for group tutorials.

6.2 Tutorials

There is one 45-minute tutorial session per week as shown on the student's timetable. Tutors will be available for consultation at designated times.

6.3 Laboratories

All students have 24-hour access to the Faculty of Engineering & the Built Environment PC Laboratory on West Campus. At certain times the laboratory will be used by other students for classes and tutorials. At such times students in the laboratory for formal sessions have preferential access to facilities. This laboratory will be used for the simulation and programming aspect of the course. The B-Lab, located on the first floor of the Chamber of Mines building, West Campus, will be used for the electrical aspects of the course.

The laboratory will be fully supervised one afternoon per week from 14h15 to 17h00 as shown on the student's timetable. The student must ensure that their attendance is recorded before the end of the laboratory session. The demonstrators are not compelled to remain in the laboratory beyond the end of the session.

Students must work in groups of two during the formal laboratory sessions. Each student will be required to complete all of the laboratory exercises as specified during the course. Two hours per week are allocated for such work. Laboratory attendance is indispensable for the understanding of course material.

Students must select a laboratory partner for the duration of the course. The relevant laboratory exercise must be read and understood before the start of each laboratory session. Students will be assigned a workstation during each laboratory session on a first-come first-serve basis.

An ICAM student card will be used to gain access to the PC pool and B-lab. All students inside either of the laboratories at a given time are responsible for equipment reported damaged or missing during that time. It is therefore up to the individual to ensure that their card is never used by another person, and that fellow students behave responsibly inside the laboratory.

No hardware may be removed from any of the laboratories by a student. No software may be copied from the PC laboratory without permission from the laboratory co-ordinator. During formal laboratory sessions a demonstrator must be consulted if problems with workstations, printers or the network occur. Outside of formal laboratory sessions problems must be reported to the relevant supervisors. **Under no circumstances should students attempt to repair equipment themselves**.

Infringements of any of the above instructions will be reported to the Dean of Engineering & the Built Environment and may result in serious disciplinary action being taken.

6.4 Course Project:

Details on the course project, including deliverables required and deadline, will be provided during the course in the form of handouts as well as being made available on the course home page.

The School's policy on timely submission of projects and assignments will be enforced and must be read and understood by the student.

6.5 Practice:

Learning to implement a microprocessor and to program well requires a lot of practice. Students are expected to spend **an extra 3 hours per week** of their own time practising material covered during lectures, tutorials and laboratories. Some extra reading material may also be provided.

6.6 Consultation:

All questions arising from the laboratory exercises and project must be directed to the responsible demonstrators. Questions relating to use of the laboratories and their equipment must be directed to the relevant managers.

Questions relating to lectures and course material must be directed to the course lecturer either during lectures or during formal consultation periods. Formal consultation periods will be scheduled at students' request. Students must, however, try to resolve any problems among themselves first. Groups of two or more students should schedule an appointment with the lecturer if they are unable to resolve their problem.

7 Information to Support the Course

7.1 Prescribed Text/Reading

The following textbooks are prescribed for the course, both are available for download from the Library website:

- Harris, D. and Harris, S., *Digital design and computer architecture*, 1st Edition, Elseiver, 2008, ISBN 9780123704979. (Library shelf TK 7868.D5 HAR)
- Sweetman, D., *See MIPS run*, 2nd Edition, Elsevier, 2007, ISBN 9780120884216 (Library shelf QA 76.39.A73 SWE)

The following textbook was previously prescribed and may be of assistance to students:

- Jain, RP., *Modern digital electronics*, 1st Edition, McGraw-Hill Science/Engineering, 2008. ISBN-10: 0073404578, ISBN-13:978-0073404578.

7.2 Other References

There are numerous texts, books and magazines available in the Engineering and Geo/Maths libraries from which the students should supplement their reading. Many good books are available at major bookshops and these can be used to supplement the course material if the student wishes to do so, but they are certainly not essential.

7.3 Course Home Page

`http://dept.ee.wits.ac.za/~grant`

8 Other Information

8.1 Administrative details

Further information and announcements regarding the course will be communicated either via the web page, verbal announcements or printed material distributed during lectures. Handouts for laboratories, tutorials and the project will be issued during the course.

Although a Personal Computer is not a requirement for any Electrical, Information or Biomedical Engineering course, it is strongly recommended as a useful tool from the second year of study onwards.

All students are expected to regularly consult the course home page.