

University of Macau
Department of Electromechanical Engineering
CPTG301 – Microprocessors
Syllabus
2nd Semester 2011/2012
Part A – Course Outline

Compulsory course in Electromechanical Engineering

Course description:

Students will learn the principle and how to program a microprocessor. ARCHITECTURE; REGISTERS - General purpose register, special purpose register; TIMING - Machine Cycle; INSTRUCTION - Format, Opcode, Operand, Addressing Method, Instruction Set; PROGRAMMING - Programming in Assembly Language; INTERRUPT - Interrupt Controller, Interrupt Subroutine; I/O - Timer/Counter

Prerequisite:

MECH450 – Electronics & Instrumentation

Textbook:

- M. A. Mazidi, J. Mazidi, R. McKinlay, *The 8051 microcontroller and embedded systems*, 2nd Edition, Prentice Hall, 2006.

References:

- I. Scott MacKenzie, Raphael C.-W. Phan, *The 8051 microcontroller*, 4th Edition, Prentice Hall, 2007.
- Proteus - user manual
- Keil - user manual
- Specification sheet of various IC components

Course objectives:

1. Introduce microprocessor system architecture (including memory and I/O), microprocessor programming model and data structures. [c, g]
2. Learn to estimate CPU execution time, memory access time, timing delays and interrupt priority. [a]
3. Work in a team to design and conduct experiments on arithmetic operations, external memory access, and LCD interfacing, through Proteus and Keil simulator [a, b, d, l]
4. Gain knowledge on assembly language programming to practical applications [g]
5. Understand 8051 applications to engineering such as counter and timer, stepper motor interfacing, ADC, DAC, sensor interfacing, interrupts [c]

Topics covered:

1. **Introduction** – Microprocessors; Binary-Decimal Conversion; Binary Arithmetic; Negative Binary; Signed Binary Numbers; 1's Complement Form; 2's Complement Form; Signed Binary Arithmetic; Binary-Hexadecimal Conversion.
2. **Computer Structure** – Computer Components; Computer Architecture; Internal Organization of Computers; Buses; Code, Data, Program; Microprocessor & Microcontroller; Criteria for Choosing a Microcontroller; Overview of the 8051 Family; Basics of Memory Devices; MCS-51 Memory Organization; Special Function Registers (SFR), Program Status Word (PSW).
3. **8051 Assembly Language Programming** – Registers; Structure of Assembly Language; Assembling; Move, Jump, Loop, and Call Instructions.
4. **Arithmetic & Logic Operations** – Compare, Addition, Subtraction, Multiplication, and Division Instructions; Overflow Flag and Rotating Bit; Logic Operations; RAM and Stack in the 8051; Push and Pop Operations.
5. **I/O port Programming** – Ports; Important Pins; Power-On Reset; Sending and Receiving Data via Port 0; Address & Data Modes of Port 0; Accessing Ports 1 and 2; Special Role of Port 3.

6. **Single-Bit Instructions & Programming** – SETB, CLR, CPL, JB, JNB, JBC Instructions; CY-Related Instructions.
7. **8051 Addressing Modes** – Immediate Mode; Direct Addressing Mode; Register Indirect Addressing Mode; Indexed Addressing Mode.
8. **Binary Coded Decimal (BCD)** – Unpacked BCD; Packed BCD; Arithmetic Programming of BCD; Packed BCD-ASCII Conversion.
9. **Interfacing to External Memory** – Memory Address Decoding; Address Decoders; Address Multiplexing; On-Chip & Off-Chip Code ROM; Data Memory Space; External ROM for Data; Connection to External Data RAM; Program and Data in an External ROM.
10. **Counter/Timer Programming in Assembly** – Timer 0 & 1 Registers; TMOD Register; Using XTAL Clock; M0/M1/M2 Modes; Timer Programming; Counter Programming.
11. **LED & LCD Interfacing** – Interfacing LED; Interfacing 7-Segment Display; LCD Operation; LCD Pin Descriptions; LCD Commands; LCD Address; Wait, Send Command, and Text Display Subroutines; Initialization of the LCD; Displaying of Character Sequence; Changing Position of Text; Displaying Numbers; LCD Character Generator RAM; Custom Character; Animation on LCD.
12. **Stepper Motor Interfacing** – Stepper Motor and its Advantages and Disadvantages; Working Principle of Stepper Motor; Connection to the 8051; Full Step and Half Step and their Programming; Motor Speed; Holding Torque; Step Angle. Digital-to-Analog Converter (DAC).
13. **Interrupt Programming in Assembly** – Polling vs. Interrupts; Advantages of Interrupts; Interrupt Service Routine (ISR); Steps in Executing an Interrupt; Interrupt Vector Table; Programming Timer Interrupts; External Interrupts; Level-Triggered & Edge-Triggered Interrupts; Setting Interrupt Priority; Interrupt inside an Interrupt; Triggering the Interrupt by Software.

Class schedule and credits:

Timetabled work in hours per week			No of teaching weeks	Total hours	Total credits	No / Duration of exam papers
Lecture	Tutorial	Practice				
2	0	2	14	56	3	1 / 3hrs

Topic Outline:

Week No.	No. of hours	Topics
1	2	Introduction Microprocessors; Binary-Decimal Conversion; Binary Arithmetic; Negative Binary; Signed Binary Numbers; 1's Complement Form; 2's Complement Form; Signed Binary Arithmetic; Binary-Hexadecimal Conversion.
1, 2	4	Computer Structure Computer Components; Computer Architecture; Internal Organization of Computers; Buses; Code, Data, Program; Microprocessor & Microcontroller; Criteria for Choosing a Microcontroller; Overview of the 8051 Family; Basics of Memory Devices; MCS-51 Memory Organization; Special Function Registers (SFR), Program Status Word (PSW).
2, 3, 4	8	8051 Assembly Language Programming Registers; Structure of Assembly Language; Assembling; Move, Jump, Loop, and Call Instructions. Laboratory Experiment Assembly Programming – Part 1
4, 5, 6	8	Arithmetic & Logic Operations Compare, Addition, Subtraction, Multiplication, and Division Instructions; Overflow Flag and Rotating Bit; Logic Operations; RAM and Stack in the 8051; Push and Pop Operations. Laboratory Experiment Assembly Programming – Part 2
6, 7	4	I/O port Programming Ports; Important Pins; Power-On Reset; Sending and Receiving Data via Port 0;

		Address & Data Mode of Port 0; Accessing Ports 1 and 2; Special Role of Port 3.
7	2	Single-Bit Instructions & Programming SETB, CLR, CPL, JB, JNB, JBC Instructions; CY-Related Instructions.
8	2	8051 Addressing Modes Immediate Mode; Direct Addressing Mode; Register Indirect Addressing Mode; Indexed Addressing Mode.
8	2	Binary Coded Decimal (BCD) Unpacked BCD; Packed BCD; Arithmetic Programming of BCD; Packed BCD-ASCII Conversion.
9	4	Interfacing to External Memory Memory Address Decoding; Address Decoders; Address Multiplexing; On-Chip & Off-Chip Code ROM; Data Memory Space; External ROM for Data; Connection to External Data RAM; Program and Data in an External ROM. Laboratory Experiment External Data Memory
10	4	Counter/Timer Programming in Assembly Timer 0 & 1 Registers; TMOD Register; Using XTAL Clock; M0/M1/M2 Modes; Timer Programming; Counter Programming.
11, 12	6	LED & LCD Interfacing Interfacing LED; Interfacing 7-Segment Display; LCD Operation; LCD Pin Descriptions; LCD Commands; LCD Address; Wait, Send Command, and Text Display Subroutines; Initialization of the LCD; Displaying of Character Sequence; Changing Position of Text; Displaying Numbers; LCD Character Generator RAM; Custom Character; Animation on LCD. Laboratory Experiment LCD LM032L Display
12, 13	4	Stepper Motor Interfacing Stepper Motor and its Advantages and Disadvantages; Working Principle of Stepper Motor; Connection to the 8051; Full Step and Half Step and their Programming; Motor Speed; Holding Torque; Step Angle. Digital-to-Analog Converter (DAC).
13, 14	6	Interrupt Programming in Assembly Polling vs. Interrupts; Advantages of Interrupts; Interrupt Service Routine (ISR); Steps in Executing an Interrupt; Interrupt Vector Table; Programming Timer Interrupts; External Interrupts; Level-Triggered & Edge-Triggered Interrupts; Setting Interrupt Priority; Interrupt inside an Interrupt; Triggering the Interrupt by Software.

Contribution of course to meet the professional component:

This course prepares students to work professionally in the area of **Electronics**.

Relationship to EME programme objectives and outcomes:

This course primarily contributes to Electromechanical Engineering Programme outcomes that develop student abilities to:

- (a) an ability to apply knowledge of mathematics, science, and engineering;
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data;
- (d) an ability to function on multidisciplinary teams.
- (l) an ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.

The course secondarily contributes to Electromechanical Engineering programme outcomes that develop student abilities to:

- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- (g) an ability to communicate effectively.

Course content:

Maths	Basic Sciences	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total 100%
30	0	10	20	0	40	100

Persons who prepared this description:

Mr. Seng Kin Lao

Part B General Course Information and Policies

2nd Semester 2011/2012

Instructor: Mr. Seng Kin Lao
Office Hour: By appointment
Email: skeltonl@umac.mo

Office: N327C
Phone: (853) 8397-4379

Time/Venue:

TBA

Assessment:

Final assessment will be determined on the basis of:

Homework: 15%
Experiments: 20%
Mid-term I: 25%
Final Exam (Comprehensive): 40%

Grading System:

The credit is earned by the achievement of a grade from 'A' to 'D'; 'F' carries zero credit.

Grades are awarded according to the following system:

Letter Grades	Grade Points	Percentage
A	4.0 (Excellent)	93-100
A-	3.7 (Very good)	88-92
B+	3.3	83-87
B	3.0 (Good)	78-82
B-	2.7	73-77
C+	2.3	68-72
C	2.0 (Average)	63-67
C-	1.7	58-62
D+	1.3	53-57
D	1.0 (Pass)	50-52
F	0 (Fail)	Below 50

Comment:

The objectives of the lectures are to explain and to supplement the text material. Students are responsible for the assigned material whether or not it is covered in the lecture. Students who wish to succeed in this course should read the assignments prior to the lecture and should work all homework and lab assignments. You are encouraged to look at other sources (other texts, etc.) to complement the lectures and text.

Homework Policy:

The completion and correction of homework is a powerful learning experience; therefore:

- There will be approximately 5 homework assignments.
- Homework is due one week after assignment unless otherwise noted, no late homework is accepted.
- Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework
- The homework grade will be based on the average of the assignment grades.

Lab Assignment/Mid-term Exam:

One mid-term exam will be held during the semester. There will be 4 lab experiments, including assembly language programming for arithmetic operations (addition, subtraction, multiplication, and division), accessing external data memory, and LCD interfacing. Lab reports are due two weeks after experiments. No late report is accepted.

Note:

Recitation session is important part of this course and attendance is strongly recommended.

- Check UMMoodle (webcourse.umac.mo) for announcement, homework, experiments and lectures. Report any mistake on your grades within one week after posting.
- No make-up exam is give except for CLEAR medical proof.
- No exam is given if you are 15 minutes late in the midterm exam and 30 minutes late in the final exam. Even if you are late in the exam, you must turn in at the due time.
- Cheating is absolutely prohibited by the university.

Appendix - Rubric for Programme Outcomes

Rubric for (a)	5 (Excellent)	3 (Average)	1 (Poor)
Understand the theoretic background	Students understand theoretic background and the limitations of the respective applications.	Students have some confusion on some background or do not understand theoretic background completely	Students do not understand the background or do not study at all
Use a correct model and formulation correctly	Students choose a model correctly and properly apply correct techniques	Students choose a wrong model sometime, use a wrong formula, or a different technique	Students use a wrong model and wrong formula, or do not know how to model
Compute the problem correctly	Students use correct techniques, analyze the problems, and compute them correctly	Students sometime solve problem mistakenly using wrong techniques	Students do not know how to solve problems or use wrong techniques completely

Rubric for (b)	5 (Excellent)	3 (Average)	1 (Poor)
Conduct experiments	Student successfully completes the experiment, records the data, analyzes the experiment's main topics, and explains the experiment concisely and well.	Student successfully completes the experiment, records the data, and analyzes the experiment's main topics.	Student either does not complete the experiment successfully, or completes it successfully but does not record the correct data.
Design experiments	Student understands what needs to be tested and designs an appropriate experiment that takes into account the limitations of the equipment and measurement accuracy.	Student understands what needs to be tested and designs an appropriate experiment, but may not fully understand the limitations of the measurements.	Student does not understand what needs to be tested and/or does not design an appropriate experiment.

Rubric for (c)	5 (Excellent)	3 (Average)	1 (Poor)
Design capability and design constraints	Student understands very clearly what needs to be designed and the realistic design constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	Student understands what needs to be designed and the design constraints, but may not fully understand the limitations of the design constraints	Student does not understand what needs to be designed and the design constraints.
Process to meet desired needs	Student understands very clearly the process of the design	Student understands what the needs of the process design, but may not fully understand the limitations of the design constraints	Student does not understand the process.

Rubric for (d)	5 (Excellent)	3 (Average)	1 (Poor)
Ability to work in teams	Performance on teams is excellent with clear evidence of equal distribution of tasks and effort as well as frequent meetings of the team members.	Performance on teams is acceptable with one or more members carrying a larger amount of the effort as well as infrequent meetings of the members or one or more members being absent from several meetings.	Performance on teams is poor to unacceptable with one or two members clearly carrying the majority of the effort as well as inadequate team meeting or one or more members missing the majority of the meetings.
Multi-disciplinary teams	Team consists of members from two or more different engineering/science/business fields (this could contain some members not actually enrolled in the course but interacting as part of a competition, collaboration, etc.)	Team consists of members from two or more concentrations within the Department of Electromechanical Engineering	Team consists of members from the same concentration within the Department of Electromechanical Engineering

Rubric for (g)	5 (Excellent)	3 (Average)	1 (Poor)
Professional Impact	Student's/Team's/Group's document(s)/presentation(s) is/are considered to be of professional quality	Student's/Team's/Group's document(s)/presentation(s) is/are considered acceptable for college level work	Student's/Team's/Group's document(s)/presentation(s) is/are considered unacceptable for college level work
Written Component	Document is nearly error free with sophisticated use of vocabulary, formatted properly, with well developed concise sentences and paragraphs	Document contains some errors with a somewhat colloquial vocabulary, minor formatting issues, with some organizational issues that do not interfere with communication	Document contains many errors, very colloquial vocabulary, with severe organizational issues that interfere with communication. Document would be considered unacceptable.
Oral Component	Presentation is consistent, uniform, clear, direct, complete and captivating with very clear fonts and graphics with an excellent layout that clearly presents the technical content	Presentation is somewhat inconsistent between speakers, occasionally difficult to hear, with an acceptable layout containing acceptable fonts and graphics that adequately presents the technical content	Presentation is very inconsistent between speakers, difficult to hear with a poor layout containing illegible fonts and graphics that poorly presents the technical content. Would be considered unacceptable

Rubric for (l)	5 (Excellent)	3 (Average)	1 (Poor)
Use modern computer and software tools in engineering practice	Student uses the computer and software to correctly analyze engineering problems and/or create engineering designs, and understands the limitations of the software.	Student uses the computer and software to correctly analyze engineering problems and/or create engineering designs.	Student does not use the computer and software to correctly create engineering designs and/or does not correctly interpret the results.