University of Macau
Department of Computer and Information Science
ELEC210 – Digital Systems II
Syllabus
1st Semester 2011/2012
Part A – Course Outline

Compulsory course in Computer Science

Course description:

3 credits.
Based on the previous study of various Gates and their characteristic curves, Switching Algebra and Combinational Circuits and Systems in Digital Systems I, this Digital Systems II will further teach more important part of digital systems – Sequential Logic Circuits and Systems, which includes bi-stable elements: S-R / J-K / D / T / T' flip-flops, single-stable elements, integrated timer, Schmitt trigger as well as ROM (Read Only Memory), RAM (Random Access Memory), CPLD (Complex Programmable Logic Devices), FPGA (Field-Programmable Gate Arrays) etc. and their applications; analyze and design the basic circuits: registers and shift-registers, counters, shift-register type counters, synchronous/asynchronous state machines, sequential PLDs, sequential-pulse generator, function generator, etc. Learn their feature characteristics and calculate the parameter values of components. The course will teach students to grasp the basic analysis, design and CAD principles and be able to make analysis and design practices in both board-level & VLSIC (Very Large Scale Integrated Circuit) systems independently. Some up-to-date advanced Computer-Aided Design Tools will be introduced and used in this course.

Course type:

Theoretical with substantial laboratory/practice content

Prerequisites:

- ELEC110

Textbook(s) and other required material:

- John F. Wakerly, *Digital Design–Principles & Practices* (4th edition or higher), Prentice-Hall Inc., ISBN 0-13-173349-4, published in the summer of 2005, from Chapter 7 to the end.

References:

- Ronald J. Tocci, Neal Widmer and Greg Moss, *Digital Systems: Principles and Applications* (11th Edition or higher) Pearson Custom Electronics Technology, Jul. 2010.
- William J. Dally and John W. Poulton, *Digital System Engineering*, by Apr. 2008.
- Donald D. Givone, *Digital Principles and Design*, The State University of New York, McGraw-Hill Higher Education, ISBN: 0072551321 / 9780072551327, Jul. 2002.
- John P. Uyemura, *A First Course in Digital Systems Design: An Integrated Approach*, by Brooks/Cole Publishing Company, ISBN: 0534934129, Mar. 2003.

Major prerequisites by topic:

- Fundamental knowledge of electricity and electronics circuits.
- Knowledge of gates, switching algebra, combinational circuits.
- Analysis and design methods of combinational circuits.
- Knowledge of applying CAD tool on analyzing and designing combinational circuits.

Course objectives:

- Provide the useful knowledge, analysis & design methods and development skills to students, educate them be able to analyze, design, create, implement, test and adjust the various digital systems according to the concrete demands of real world by using the existing popular digital hardware components and CAD tools in both board-level & VLSIC systems [a, b, c, e, k, h, j];
- Through experiments to train students having the capability of using components to construct the required digital systems and using measurement instruments to test and adjust them [a, b, c, e, k, d].

Topics covered:

- **Basic elements of Sequential Logic Circuits (6 hours):** such as bi-stable elements: S-R / D latches / J-K / D / T / T' flip-flops;
- **Basic circuits of Sequential Logic Circuits (8 hours):** such as single-stable trigger, integrated timer, Schmitt trigger as well as ROM (Read Only Memory), RAM (Random Access Memory), CPLD (Complex Programmable Logic Devices) and FPGA (Field-Programmable Gate Arrays) etc.;
- **Analysis & Design method of Sequential Logic Circuits (14 hours)**: such as analyze and design registers and shift-registers, counters, shift-register-type counters, synchronous/asynchronous state machines, sequential PLDs, single pulse generator, sequential-pulse generator, function generator etc.;
- **VHDL programming language and a CAD tool for designing and simulating the sequential logic circuits (2 hours).**

Class/laboratory schedule:

Timetabled work in hours per week			No of teaching weeks	Total hours	Total credits	No/Duration of exam papers
Lecture	**Tutorial**	**Practice**				
2	1.3	0.7	14	56	3	1 / 2 hours

Student study effort required:

Class contact:	
Lecture	28 hours
Tutorial	18 hours
Lab experiment practice	10 hours
Other study effort	
Self-study	28 hours
Homework assignment	18 hours
Project / Case study	4 hours
Total student study effort	106 hours

Student assessment:

Final assessment will be determined on the basis of:

Homework	20%
Practice & project	30%
Final exam	50%

Course assessment:

The assessment of course objectives will be determined on the basis of:

- Homework, lab experiment practice, project and exams
- Course evaluation

Course outline:

Weeks	Topic	Course work
1-3	**Components of Sequential Logic Circuits**	Assignment

Weeks	Topic	Course work
	Bistable Elements: Basic and Synch. S-R Latches, T' Latch, J-K / D / T / T' Flip-Flops, Transformation between different Flip-Flops.	#1,2,3 Lab #1
4-5	**Sequential Logic Circuits and Digital Systems: Analysis and Design** Registers: Shift Registers, Integrated Circuits of Registers, Application Examples of IC Registers.	Assignment #4 Lab #2
6-7	**Sequential Logic Circuits and Digital Systems: Analysis and Design** Counters: Asynchronous Counter, Synchronous Counter, Shift-Register-Type Counter.	Assignment #5
8-10	**Sequential Logic Circuits and Digital Systems: Analysis and Design** Analysis and Design of Digital Systems: Analysis of Asynchronous & Synchronous Counters, Design of Sequential Logic Circuits, Analysis and Design Examples.	Assignment #6,7 Lab #3
11-12	**Pulse Generator** Integrated Timer, Single-Stable Element, Pulse Generator, Oscillator.	Assignment #8 Lab #4
13	**Computer-Aided Design Tools** HDL and VHDL hardware description language for designing and simulating sequential logic circuit, CAD Tool: Max+Plus-II, design and simulate sequential logic circuits and digital systems by using CAD tool.	Assignment #9 Lab #5
14	**Memory and CPLD** Structure and working principle of ROM and RAM, CPLD and its applications.	Project #1

Contribution of course to meet the professional component:
This course prepares students with fundamental knowledge and experiences to analyzing and constructing digital systems.

Relationship to CIS program objectives and outcomes:
This course primarily contributes to the Computer Science program 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.
(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.
(e) an ability to identify, formulate, and solve engineering problems.
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The course secondarily contributes to the Computer Science program outcomes that develop student abilities to:
(d) an ability to function on multidisciplinary teams.
(h) the broad education necessary to understand the impact of engineering solution in a global, economic, environmental, and societal context.
(j) a knowledge of contemporary issues.

Relationship to CS program criteria:

Criterion	DS	PF	AL	AR	OS	NC	PL	HC	GV	IS	IM	SP	SE	CN

Scale: 1 (highest) to 4 (lowest)		2					2	2					2	

Discrete Structures (DS), Programming Fundamentals (PF), Algorithms and Complexity (AL), Architecture and Organization (AR), Operating Systems (OS), Net-Centric Computing (NC), Programming Languages (PL), Human-Computer Interaction (HC), Graphics and Visual Computing (GV), Intelligent Systems (IS), Information Management (IM), Social and Professional Issues (SP), Software Engineering (SE), Computational Science (CN).

Course content distribution:

Percentage content for			
Mathematics	Science and engineering subjects	Complementary electives	**Total**
0%	100%	0%	100%

Coordinator:
Prof. Man I Vai

Persons who prepared this description:
Prof. Ming Chui DONG, Mr. Chi Pio TOU

Part B General Course Information and Policies

1st Semester 2011/2012

Instructor: Prof. Ming Chui DONG   Office: B3-106
Office Hour: by appointment   Phone: 8397-4520
Email: dmc@sftw.umac.mo

Time/Venue: Tue 14:30 pm – 16:30 pm, HG02 (lectures)
Wed 13:30 pm – 15:30 pm, WLG104 (tutorial for CIS-A)
Fri 09:00 am – 11:00am, U107 (tutorial for CIS-B)
Sat 09:00 am – 11:00am, U101 (tutorial for ECE)

Grading Distribution:

Percentage Grade	Final Grade	Percentage Grade	Final Grade
100 - 93	A	92 - 88	A–
87 - 83	B+	82 - 78	B
77 - 73	B–	72 - 68	C+
67 - 63	C	62 - 58	C–
57 - 53	D+	52 - 50	D
below 50	F		

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 project 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 9 homework assignments.
- Homework is due two weeks after assignment unless otherwise noted, no late homework is accepted.
- The course grade will be based on the average of the HW grades.

Course Project:
The project is probably the most exciting part of this course and provides students with meaningful comprehensive experience to practice and enhance knowledge of digital systems:

- The requirements will be announced in advance.
- The project will be presented by written report.

Quiz
No mid-term exam is held during the semester, but there will be occasional in-class quiz in tutorial courses.

Exam:
Only final exam will be held during the semester, which is closed book, 2-hour examinations.

Note

- Recitation session is important part of this course and attendance is strongly recommended.
- Check http://www.inesc-macau.org.mo/people/dmc/ for announcement, homework, Lab experiments and lectures. Report any mistake on your grades within one week after posting.
- No make-up exam is given except for CLEAR medical proof.
- Cheating is absolutely prohibited by the university.

Appendix:

Rubric for Program 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	Performance on teams is	Performance on teams is	Performance on teams is

in teams	excellent with clear evidence of equal distribution of tasks and effort as well as frequent meetings of the team members.	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.	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 Computer and Information Science.	Team consists of members from the same concentration within the Department of Computer and Information Science.

Rubric for (e)	5 (Excellent)	3 (Average)	1 (Poor)
Identify applications in engineering systems	Students understand problem and can identify fundamental formulation.	Students understand problem but cannot apply formulation, or cannot understand problem.	Students cannot identify correct terms for engineering applications.
Modeling, problem formulation and problem solving	Students choose and properly apply the correct techniques.	Students model correctly but cannot select proper technique or model incorrectly but solve correctly accordingly.	Students at loss as to how to solve a problem.

Rubric for (h)	5 (Excellent)	3 (Average)	1 (Poor)
Scope of content	Students will demonstrate material, items, or topics characterized by a sophisticated array of information, insight, and understanding.	Students demonstrate significance reflecting an acceptable degree of perception and thoughts.	Students have limited abilities to relate, incorporate, or demonstrate knowledge of subject with a dynamic breadth.
Impact of process	Students will employ techniques, designs, ideas, and knowledge demonstrating a profound ability to improve and possess broad applications with a keen a series of actions, changes, or functions.	Techniques, designs, ideas, and knowledge present some understanding and ability to demonstrate progression, significance, and influence.	Techniques, designs, ideas, and knowledge present limited progression, significance, and influence.

Rubric for (j)	5 (Excellent)	3 (Average)	1 (Poor)
Relevance to the present time	Student displays an understanding of the theoretical or practical impact and an ability to correlate a subject,	Student is able to display an understanding of current topics and issues with some knowledge regarding their impact in a bigger global	Student has difficulty demonstrating an awareness or familiarity with current topics and issues relevant to most

	perception, communication, association and reasoning from a global and societal perspective.	and societal sense.	current global and societal affairs.
Rubric for (k)	**5 (Excellent)**	**3 (Average)**	**1 (Poor)**
Use modern principles, skills, and tools in engineering practice	Student applies the principles, skills and tools to correctly model and analyze engineering problems, and understands the limitations.	Student applies the principles, skills and tools to analyze and implement engineering problems.	Student does not apply principles and tools correctly and/or does not correctly interpret the results.