University of Macau

Faculty of Science and Technology

Department of Electrical and Computer Engineering

Part A: Course Outline

Course Title:	Control Electronics and Automation		
Course Code:	ELEC326	Year of Study:	3
Course Mode:	Theoretical with substantial laboratory/ practice content		
Compulsory/Elective:	Elective		
Course Prerequisites:	ELEC223 – Applied Electronics II		
Prerequisite Knowledge	Electronics basis; circuit analysis; digital system; preliminary control theory		
Class/Laboratory Schedule:	3 hours for lecture and 2 hours for tutorial/experiment per week		
Duration	One semester	Credit Units	3.5
Text Books and References:	[1] Curtis D. Johnson, *Process Control Instrumentation Technology*, 8th ed., Prentice-Hall, 2005. [2] G. F. Franklin, J. D. Powell, A. Emami-Naeini, *Feedback Control of Dynamic Systems*, 2nd ed., Addison –Wesley, 1991. [3] Karl J. Astrom, Bjorn Wittenmark, *Computer Controlled Systems - Theory and Design*, 2nd ed., Prentice Hall, 1990. [4] Richard C. Dorf, Robert H. Bishop, *Modern Control Systems*, 9th ed., Prentice Hall, 2001. [5] Earl Cox, The *Fuzzy Systems Handbook*, Academic Press, 1994 [6] J. Yan, M. Ryan, J. Power, *Using Fuzzy Logic*, Prentice Hall, 1994. [7] Bernard Widrow, Eugene Walach, *Adaptive Inverse Control*, Prentice Hall, 1995.		
Course Description:	This course will present a comprehensive treatment of the fast-paced field of electronic circuits for modern automatic control systems with mainly focusing on process control system. The focus of the course is not only the state-of-art control-subsystem electronics but also with the special emphasis on their interconnections. In addition, simulation of modern control algorithm using in a closed-loop control system and the application of industrial-type programmable logic controller (PLC) for discrete-state control will also be included. Throughout this course, both process control system design and implementation will be given with balanced treatment in order to give students the prospectus in modern control system usage and its latest investigations.		
Topics Covered	1. Introduction 2. Sensors 3. Signal Conditioners 4. Controller 5. Control Elements and Actuators		

<table>
<tr><td>Course Objectives:</td><td colspan="3">1. To introduce to students the relevant electronic circuits with various types of sensors and final control elements for a closed-loop process control [a, b, c, d, e, k]
2. To introduce to students some common control algorithms, e.g. PID control and fuzzy-logic control etc, and their analog and digital implementations [a, b, c, d, e]
3. To prepare students to design a controller for a given process in a close-loop system by simulation [b, c, k, l]
4. To prepare students to design and implement a discrete-state controller using programmable logic controller [b, c, d, k, l]</td></tr>
<tr><td>Course Assessment:</td><td colspan="3">Mid-Term Examination: 20%
Final Examination: 30%
Experiments: 10%
Project - Simulation: 20%
Project – PLC: 20%</td></tr>
<tr><td>Relationship to Program Objectives and Outcomes</td><td colspan="3">This course primarily contributes to EEE program outcomes that develop students abilities to:
a. Ability to apply knowledge of mathematics, science and engineering.
b. Ability to design and conduct experiments.
c. Ability to design a system, component or process to meet desired needs.
k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.
l. Ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.
This course secondarily contributes to EEE program outcomes that develop students abilities to:
d. Ability to function on multidisciplinary teams.
e. Ability to identify, formulate and solve engineering problems.</td></tr>
<tr><td rowspan="4">Course Contents and Relationship to Program Criteria:</td><td>Week no.</td><td>Topics</td><td>Program Criteria</td></tr>
<tr><td>1</td><td>Introduction
Automatic control purpose, classification of control system, process control system, evaluation of control system, analog vs. digital control, control system simulation techniques</td><td>CS, ES</td></tr>
<tr><td>3</td><td>Sensors
Sensor general concepts, type of sensors, thermal sensors, optical sensors, mechanical and other sensors</td><td>DIC, BS, ES</td></tr>
<tr><td>3</td><td>Signal Conditioner
Role of signal conditioning, bridge circuits, instrumentation amplifiers, voltage – current - frequency converter, RC filters, cold-junction compensator, comparator, DAC and ADC, data acquisition system</td><td>DIC, CS, ES</td></tr>
</table>

	6	**Controllers** General control principle, analog and digital controller, PID controller (algorithm, design and its analog and digital implementation), introduction to fuzzy logic controller, discrete state control, programmable logic controller (PLC)	DIC, CS, ES, DE, DM
	1	**Control elements and actuators** Output signal conversions, actuators, control elements, pulse width modulation, step motor	CS, ES
Contribution of Course to meet the professional component:	This course trains students to work professionally in the area of control electronics and automation. Students should be able to apply knowledge of mathematics and engineering, modern control engineering simulation tool; and design a part of or a whole controlling system to meet desired needs.		
Course Instructor(s):	Dr. Sio-Weng Ting (Tony)		
Prepared by:	Dr. Sio-Weng Ting (Tony)		

Part B: General Course Information and Policies

Instructor: Dr. Sio-Weng Ting Office: Block I, A702

Office Hour: Wednesday 14:30-16:30, or by appointment

e-mail: tonyting@umac.mo Phone: 8468

Programme Educational Objectives

1. **Problem Solving:** Graduates have the ability to think in a critical and evaluative manner and to consider a broad perspective, in order to solve technical and nontechnical problems.
2. **Leadership and Communication:** Graduates will provide effective leadership, act in an ethical manner and skills will include the ability to communicate well and to work successfully within diverse groups.
3. **Market Acceptance:** Graduates will have successful careers in the academic environment, industrial and government organizations.
4. **Technical Competence:** Graduates will be technically competent and have a thorough grounding in the fundamentals of math and science in electrical and electronics engineering and experience in engineering design. They will be able to use modern engineering techniques, skills, and tools to fulfill societal needs.

Scale: 1 (Highest) to 4 (Lowest)

	Problem Solving	Leadership and Communication	Market Acceptance	Technical Competence
Control Electronics and Automation	2	3	2	2

Remark:

- Objective for “Problem Solving” can be achieved by mid-term exam, final exam and project.
- Objective for “Leadership and Communication” can be achieved by report writing and presentation/discussion. However, leadership training is not given by this course.
- Objective for “Market Acceptance” can be achieved by the course subject about the automation system based on the programmable logic controller.
- Objective for “Technical Competence” can be achieved by using fundamentals of math and science in communication engineering and experience in engineering project and computer simulation.

Program Criteria Policy:

Course VS Program Criteria

Scale: 1 (Highest) to 4 (Lowest)

Course	PS	DIC	BS	CS	ES	DE	LA	CV	DM
Control Electronics and Automation		3	4	2	1	4			4

Terms:

Probability and Statistics (PS), Differential and Integral Calculus (DIC), Basic Science (BS), Computer Science (CS), Engineering Science (ES), Differential Equation (DE), Linear Algebra (LA), Complex Variables (CV), Discrete Mathematics (DM)

Program Outcome Policy:

Course VS Course Outcomes

(H= Highly Related, S = Supportive, N = None)

Course	a	b	c	d	e	f	g	h	i	j	k	l
Control Electronics and Automation	H	H	H	S	S	N	N	N	N	N	H	H

The electrical and electronics engineering program outcomes are:

a. Ability to apply knowledge of mathematics, science and engineering.

b. Ability to design and conduct experiments.

c. Ability to design a system, component or process to meet desired needs.

d. Ability to function on multidisciplinary teams.

e. Ability to identify, formulate and solve engineering problems.

f. Understanding of professional and ethical responsibility.

g. Ability to communicate effectively.

h. Broad education necessary to understand the impact of engineering solutions in global and societal context.

i. Recognition of the need for and an ability to engage in life-long learning.

j. Knowledge of contemporary issues.

k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

l. Ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations

Curriculum Details

Timetabled work in hours per week			No of teaching weeks	Total hours	No /Duration of exam papers	Max marks available from:	
Lecturer	Tutor	Practice				Exams	Course
3	1	1	14	70	2/4 hours	50	50

Term: **6**th

Hours			Percentage content of					
Lecture	Lab/Tut.	Other	Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies
42	12/16	0	30	0	30	30	0	10

Design Elements

% of Design Content	Design Content in Course Work	Design Project	Design Content in Laboratories
30%	✓	✓	×

Course Assessment Policy

- Quizzes will be given frequently. One of the quizzes with the lowest scores would be discarded at the end.
- Students are required to submit reports for experiments and projects.
- No late submission is accepted for any report or assignment. Zero mark is given for copied reports and assignments.
- One mid-term exam and one final exam will be given.