University of Macau

Faculty of Science and Technology

Department of Electrical and Computer Engineering

Part A: Course Outline

Course Title:	Control Systems II		
Course Code:	ELEC 312	Year of Study:	3
Course Mode:	Theoretical with substantial laboratory/ practice content		
Compulsory/Elective:	Elective		
Course Prerequisites:	ELEC 313		
Prerequisite Knowledge	Classical Control Theory; Linear Algebra		
Class/Laboratory Schedule:	Theory class: 4 hours; Tutorial/Practice class: 2 hour (per week)		
Duration	One semester	Credit Units	3.5
Text Books and References:	[1] "Modern Control Systems," R.C. Dorf and R.H. Bishop, 12th ed., Prentice-Hall, 2010. [2] "Feedback Control of Dynamic Systems," G.F. Franklin, J.D. Powell and A. Emami-Naeini, 6th ed., Prentice-Hall, 2009. [3] "Modern Control Engineering," K. Ogata, 5th ed., Prentice-Hall, 2009. [4] "Linear System Theory and Design," C.T. Chen, 3rd ed., Oxford University Press, 1998.		
Course Description:	This course offers a continuation of control system analysis and design, with emphasis on PID control and compensator design (lead, lag, lead-lag), and an introduction to modern control theory, which covers basic concepts and principles of system modeling, analysis and controller design for linear time-invariant systems with the state space approach including state variable models, controllability, observability and stability analysis, state feedback control and observer design.		
Topics Covered	1. Introduction to modern control theory; 2. State space method and state variable models; 3. Time domain analysis, stability analysis; controllability and observability; 4. State feedback control and observer design; 5. PID control and compensator design; 6. Control system simulation using Matlab/Simulink and Control Toolbox.		
Course Objectives:	1. Introduce to students some real systems, which use modern control theory. [a, e, k] 2. Introduce to students mathematical modeling of physical systems with the state space approach. [a, e, k] 3. Introduce students to analysis of feedback control systems with the state space approach. [a, b, e, k] 4. Introduce students to design of modern control systems with the state space		

<table>
<tr><td></td><td>approach. [a, b, c, e, k]
5. Introduce students to PID control and compensator design. [a, b, c, e, k]</td></tr>
<tr><td>Course Assessment:</td><td>Assignments : 15%
Quiz :15%
Lab Experiments: 15%
Mid-term Exam: 15%
Final Exam. : 40%</td></tr>
<tr><td>Relationship to Program Objectives and Outcomes</td><td>This course primarily contributes to EEE program outcomes that develop students abilities to:
a. Ability to apply knowledge of mathematics, science and engineering.
c. Ability to design a system, component or process to meet desired needs.

This course secondarily contributes to EEE program outcomes that develop students abilities to:
b. Ability to design and conduct experiments.
e. Ability to identify, formulate and solve engineering problems.
k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.</td></tr>
<tr><td>Course Contents and Relationship to Program Criteria:</td><td>
<table>
<tr><th>Week no.</th><th>Topics</th><th>Program Criteria</th></tr>
<tr><td>1</td><td>Introduction
Basic concepts, history and examples of state space approach and modern control systems</td><td>CS, ES</td></tr>
<tr><td>2</td><td>Modeling and Representations in State Space
State space method and state variable models, state space representation and realization</td><td>DIC, ES, DE, LA</td></tr>
<tr><td>3</td><td>System Analysis via State Space Approach
Solution to state differential equation and time domain analysis, stability analysis; controllability and observability</td><td>DIC, ES, DE, LA</td></tr>
<tr><td>3</td><td>Design of State Variable Feedback Control Systems
Pole placement, full-state feedback control design, observer design, integrated control system with full-state feedback and observer</td><td>DIC, ES, DE, LA</td></tr>
<tr><td>4</td><td>PID Control and Compensator Design
PID control, compensator design (lead, lag, lead-lag, PID).</td><td>DIC, CS, ES, DE, CV</td></tr>
<tr><td>1</td><td>Matlab CAD tools and Lab Experiments</td><td>ES, CS</td></tr>
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<tr><td>Contribution of Course to meet the professional component:</td><td>This course prepares students to work professionally in the area of automatic control and the related fields. Students should be able to know and apply the knowledge of control system design and analysis with both classical and modern control approaches, to solve problems and meet desired needs in practice.</td></tr>
<tr><td>Course Instructor(s):</td><td>Dr. Feng Wan</td></tr>
<tr><td>Prepared by:</td><td>Dr. Feng Wan</td></tr>
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Part B: General Course Information and Policies

Instructor: Dr. Feng Wan Office: N423
Office Hour: Tuesday 3:30 ~ 6:30 p.m. or by appointment Phone: 4473
E-mail: fwan@umac.mo

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 Systems: II	1	3	3	1

Remark:

- Objective for “Problem Solving” can be achieved by assignments, quizzes, mid-term exam, final exam and projects.
- Objective for “Leadership and Communication” can be achieved by field visit, report writing and presentation. However, leadership training is not given by this course.
- Objective for “Market Acceptance” can be achieved by the course subject that is related to general control theory and principles as well as control technology and systems in industry.
- Objective for “Technical Competence” can be achieved by using fundamentals of math and science in electrical and computer engineering and experience in design and implementation of modern control systems.

Program Criteria Policy:

Course VS Program Criteria

Scale: 5 (Highest) to 1 (Lower)

Course	PS	DIC	BS	CS	ES	DE	LA	CV	DM
Control Systems II		1	3	1	5	2	4	2	

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 Systems II	H	S	H	S	H	N	N	N	N	N	H	N

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 Detail

ELEC 312 Control Systems I

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
4	1	1	14	84	2/5 hours	60	40

Term: 6th

Hours			Percentage content of					
Lecturer	Lab/tut	Other	Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies
56	14/14	0	20	10	20	30	10	10

Design Elements

% of Design Content	Design Content in Course Work	Design Project	Design Content in Laboratories
20%	X		X

Course Assessment Policy:

- There will be approximately 4 homework assignments. Homework is due one week after assignment unless otherwise noted, no late submission is accepted. Zero mark will be given when homework is copied. Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework.
- A number of small quizzes will be held during the semester.
- One mid-term exam and one final exam will be given with 2 hours and 3 hours respectively.