University of Macau

Faculty of Science and Technology

Department of Electrical and Computer Engineering

Part A: Course Outline

Course Title:	Control Systems I		
Course Code:	ELEC 313	Year of Study:	3
Course Mode:	Theoretical with substantial laboratory/ practice content		
Compulsory/Elective:	Compulsory		
Course Prerequisites:	ELEC 261		
Prerequisite Knowledge	Signals and Systems, Mathematical Modeling, Differential Equations and Complex Variables		
Class/Laboratory Schedule:	Theory class: 4 hours; Tutorial/Practice class: 2 hours (per week)		
Duration	One semester	Credit Units	4.5
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] "Modern Control Systems Analysis and Design Using Matlab and Simulink," R.H. Bishop, 7th ed., Addison Wesley, 1997.		
Course Description:	This is an introductory course on classical feedback control theory. It provides basic concepts and principles of system modeling, analysis and controller design for linear time-invariant systems using classical techniques including roots locus method and frequency response method. Laboratory experiments are designed so that the theory learnt in the class can be applied to real physical systems, and MATLAB CAD tools are introduced as an integral part of this course.		
Topics Covered	1. Basic concepts, history and examples of control systems; 2. Modeling of physical systems, system representations; 3. Laplace transform and transfer function analysis, system responses, stability analysis of linear systems; 4. Feedback control systems, characteristics and performance of control systems; 5. Root locus method and its applications; 6. Frequency method and its applications, stability from frequency responses; 7. Control system design and simulation using Matlab/Simulink and Control Toolbox.		
Course Objectives:	1. Introduce to students some real systems, which use automatic control. [k] 2. Introduce to students mathematical modeling of physical systems. [a, b, e] 3. Introduce students to analysis of feedback control systems. [a, c, e] 4. Introduce students to design of feedback control systems. [a, b, c, e, k] 5. Learning to apply course material to improve thinking, problem solving, and making. [b, e]		

<table>
<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 control systems</td><td>CS, ES</td></tr>
<tr><td>3</td><td>System Modeling and Representations
Basic concepts of modeling, first principle modeling of typical systems, block diagram, signal flow graph, Mason’s Law</td><td>DIC, ES, DE, CV</td></tr>
<tr><td>2</td><td>System Analysis
System responses, transfer function analysis, stability analysis, Routh-Hurwitz criterion</td><td>DIC, ES, DE, CV</td></tr>
<tr><td>2</td><td>Root Locus and Frequency Methods
Basic concepts and principles of root locus method and its applications, frequency response plots, Nyquist criterion, gain and phase margins, Nichols chart</td><td>DIC, ES, DE, CV</td></tr>
<tr><td>4</td><td>Feedback Control System Design and Analysis
Feedback control systems: characteristics, design and performance analysis, compensator design (lead, lag, lead-lag, PID).</td><td>DIC, CS, ES, DE, CV</td></tr>
<tr><td>2</td><td>Matlab CAD tools and Lab Experiments
System dynamics, control system design and performance analysis</td><td>ES, CS</td></tr>
</table>
</td></tr>
<tr><td>Contribution of Course to meet the professional component:</td><td>This course prepares students to work professionally in the area of control systems and control related fields. Students should be able to apply knowledge of mathematics and engineering, to the analysis and design of control systems to meet desired needs.</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: I	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: 1 (Highest) to 4 (Lowest)

Course	PS	DIC	BS	CS	ES	DE	LA	CV	DM
Control Systems I		3	3	4	1	2		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 I	H	S	H	S	H	N	N	N	N	N	H	S

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 313 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: 5th

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 8 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.
- Approximately three 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.