Sana'a University
Faculty of Engineering
Department: Electrical Engineering
Title of the Program: Communication Engineering and Networks

38. Course Specification of Control Systems

I. Course Identification and General Information:

1.	Course Title:	Control Systems				
2.	Course Code & Number:	CCE339				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	2	2	-	4
4.	Study level/ semester at which this course is offered:	Fourth Year / First Semester				
5.	Pre –requisite (if any):	Engineering Mechanics (BR007), Electronics 1 (PME113), Signal & Systems (CCE231)				
6.	Co –requisite (if any):	None				
7.	Program (s) in which the course is offered:	Communication & Networks Engineering Program				
8.	Language of teaching the course:	English				
9.	Location of teaching the course:	Faculty of Engineering				
10.	Prepared By:	Asst. Prof. Dr. Mohammed Abdullah Al-olofi				
11.	Date of Approval					

II. Course Description:

The course introduces the basic concepts of analog control systems, develop knowledge for model, analysis, and design of analog feedback control systems. It is include the Examples of feedback control systems – dynamics characteristics – Mathematical modeling of control systems using transfer function model and state variable model – analysis of control system in transfer function model and state variable model – block diagrams reduction and signal flow graphs – characteristics and performance of feedback control systems – transient response analysis - stability analysis - Root-Locus method – PID controllers – Frequency response method - Logarithmic plots – Bode diagram method – introduction to design, series and feedback compensation - State space design methods – controllability and observability

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– design of linear feedback control systems – linear time varying state models – pole placement design method – observer design method – transfer function of controller.

	III. Course Intended learning outcomes (CILOs) of the course	**Referenced PILOs**
a1	Show the concepts and the mathematical modeling of analog feedback control systems in transfer function model and state variable model.	**A1**
a2	Explain basic principles, components, and application of analog control systems in electrical and communication systems.	**A2**
b1	Construct the analog controllers systems and components to electrical and communication products using the control system design methods.	**B1**
b2	Analyze the electrical and communication engineering systems using modern control engineering methods and tools.	**B3**
c1	Implement the analog controllers of analog feedback control systems by using the passive and active electrical circuits.	**C2**
c2	Use the information technology tools to solve the control systems problems in the field of electrical and communication.	**C4**
d1	Work productively as an individual and as a member of a team / multi-disciplinary team.	**D1**
d2	Prepare and present effective technical reports and presentations.	**D4**

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1 Show the concepts and the mathematical modeling of analog feedback control systems in transfer function model and state variable model.	• Active Lectures. • Tutorials, • Assignments.	• Exams (Quizzes, Midterm and Final). • Homework & Assignments..
a2 Explain basic principles, components, and application of analog control systems in electrical and communication systems.	• Active Lectures, • Tutorials, • Computer-based Laboratory Work,, • Hands on Laboratory Work, • Assignments	• Exams (Quizzes, Midterm and Final). • Practical Assessment. • Reports.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1 Construct the analog controllers systems and components to electrical and communication products using the control system design methods.	▪ Active Lectures, ▪ Tutorials, ▪ Projects Work, ▪ Homework & Assignments, Hand on Laboratory works, ▪ Computer-based Laboratory Work, ▪ Case Studies	▪ Practical Assessment. ▪ Written Assessments. ▪ Project Presentations, ▪ Exams (Midterm, Final),
b2 Analyze the electrical and communication engineering systems using modern control engineering methods and tools.	▪ Tutorials ▪ Homework & Assignments, ▪ Hands-on Laboratory Work, ▪ Computer-based Laboratory Work, ▪ Case Studies.	▪ Practical Assessment, ▪ Written Assessments, ▪ Laboratory Reports

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© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1 Implement the analog controllers of analog feedback control systems by using the passive and active electrical circuits.	▪ Active Lectures, ▪ Tutorials ▪ Hands on Laboratory Work, ▪ Computer-based Laboratory Work, ▪ The Use of Communication and Information Technologies.	▪ Practical Assessments, ▪ Exams (Midterm and Final)
c2 Use the information technology tools to solve the control systems problems in the field of electrical and communication.	▪ Computer-based Laboratory Work, ▪ The Use of Communication and Information Technologies	▪ Laboratory Assessment ▪ Reports & Presentation. ▪ Practical Exam

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1 Work productively as an individual and as a member of a team / multi-disciplinary team.	▪ Laboratory small Group Works ▪ Homework & Assignments	▪ Project and Lab Reports. ▪ Written Assessments.
d4 Prepare and present effective technical reports and presentations.	▪ Laboratory Works. ▪ Homework & Assignments ▪ Projects	▪ Project Reports and Presentations. ▪ Written Assessments. ▪ Lab Reports.

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IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Introduction of control systems	a1, a2	Introduction of control systems, types of control systems, components, steps to design a control systems.	1	2
2.	Mathematical models of systems.	a1, a2, b1, b2, c1	Mathematical models of electrical, mechanical, thermal, fluid, hydraulic systems, differential equation, linear approximation of control systems, Laplace transform and theorems , transfer function models, s-plane analysis of feedback control systems, block diagram reduction, signal flow graph	1	2
3.	State-variable models	a1, a2, b1, b2, c1	State-variable model, analysis in State-variable, transform from State-variable model to transfer function model	1	2
4.	Feedback control system characteristics	a1, a2, b1, b2, c1, c2	Feedback control system characteristics, error signal analysis, sensitivity of feedback control system to parameters variation, disturbance and noise signal rejection, cost of feedback control system, design examples.	1	2
5.	Performance of the feedback	a1, a2, b1, b2, c1	Performance of 2nd order feedback control system, test input signals, steady-state error	1	2

	control system		of feedback control system, performance index of feedback control systems, design examples.		
6.	The Stability of feedback control system	a1, a2, b1, b2, c1	Stability analysis of feedback control system, The Routh-Hurwitz Stability Criterion, Relative stability, Stability of State Variable Systems, design examples.	1	2
7.	The Root Locus method	a1, a2, b1, b2, c1	Root locus concept, root locus procedures,	1	2
8.	The Root Locus method	a1, a2, b1, b2, c1	Parameters design by the root locus, PID controllers, design examples	1	2
9.	Frequency Response methods	a1, a2, b1, b2, c1	Frequency response plots, bode diagram, Frequency response measurements, performance specifications in Frequency response, design example	1	2
10.	The design of feedback control systems	a1, a2, b1, b2, c1	Approaches to System Design, Cascade Compensation Networks, Phase-Lead Design Using the Bode Diagram and Root Locus, System Design Using Integration Networks, Phase-Lag Design Using the Bode Diagram and Root Locus, Design on the Bode Diagram Using Analytical Methods, Systems with a Pre-filter, Design for Dead beat Response, design examples.	3	6
11.	The design of state variable	a1, a2, b1, b2, c1	Controllability and Observability, Full-State	2	4

	feedback control systems		Feedback Control Design, Observer Design, Integrated Full-State Feedback and Observer, Reference Inputs, Internal Model Design, design examples		
Number of Weeks /and Units Per Semester				**14**	**28**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1.	Introduction of analog control systems.	1	2	a1, a2
2.	Introduction of matlab software.	1	2	c1, c2
3.	Control Systems toolbox in matlab software.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
4.	Mathematical models of analog control system in matlab software.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
5.	Block diagram reduction in matlab software.	1	2	a1, a2, b1, b2, c1, c2d1, d2
6.	Midterm Practical Exam	1	2	a1, a2, b1, b2, c1, c2d1, d2
7.	Analysis of analog control systems response and performance .	1	2	a1, b1, b2, c1, c2, d1, d2
8.	Root locus method in matlab program.	1	2	a1, b1, b2, c1, c2, d1, d2
9.	Bode plot method in matlab program.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
10.	Analog controller design & Simulation methods in matlab program.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
11.	Review	1	2	a1, a2, b1, b2, c1, c2, d1, d2
12.	Course Project Presentation & Evaluation	1	2	a1, b1, b2, c1, c2, d1

Number of Weeks /and Units Per Semester	**14**	**28**	

C - Tutorial Aspect:

Order	Units/Topics List	Number of Weeks	Contact hours	Learning Outcomes
1.	Mathematical Systems Modeling, Electrical and Mechanical System Modeling	2	4	a1, a2, b1
2.	State-variable Models	1	2	a1, a2, b1
3.	Feedback control System Characteristics and its Performance	2	4	a1, a2, b1, b2
4.	The stability of feedback control systems	1	2	a1, a2, b1, b2
5.	The Root Locus Method.	2	4	a1, a2, b1, b2, c1
6.	The Frequency response of control systems	2	4	a1, a2, b1, b2, c1
7.	The Design of feedback control systems	2	4	a1, a2, b1, b2, c1
8.	The Design of state variable control Systems	2	4	a1, a2, b1, b2, c1
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

In general, teaching and learning in undergraduate engineering education programs should use a variety of teaching methods, such as:

- Active Lectures (supported with discussions)
- Tutorials,
- Homework & Assignments, Hands-on Laboratory Work,
- Computer-based Lab Works
- Lab Group Works.
- The Use of Communication and Information Technology.
- Case Studies.
- Projects

VI. Assignments & Reports:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Problems, and advance problems, and computer problems of the Chapter 2	a1, a2, b1, c1, d1	2nd	1
2.	Problems, and advance problems, and computer problems of the Chapter 3	a1, a2, b1, c1, c2, d1, d2	3rd	1
3.	Problems, and advance problems, and computer problems of the Chapter 4, 5	a1, a2, b1, b2, c1, c2, d1, d2	5th	2
4.	Problems, and advance problems, and computer problems of the Chapter 6, 7	a1, a2, b1, b2, c1, c2, d1, d2	9th	2
5.	Problems, and advance problems, and computer problems of the Chapter 8	a1, a2, b1, b2, c1, c2, d1, d2	10th	3
6.	Problems, and advance problems, and computer problems of the Chapter 10	a1, a2, b1, b2, c1, c2, d1, d2	13th	3
7.	Problems, and advance problems, and computer problems of the Chapter 11	a1, a2, b1, b2, c1, c2, d1, d2	14th	3
8.	Laboratory Reports	a1, b1, b2, c1,c2, d1, d2	3rd to 13th	15
	Total			**30**

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VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Quizzes	4th, 9th & 13th	10	5%	a1, a2, b1, b2, c1, d1
2.	Assignments & Reports	2nd to 14th	30	15%	a1, a2, b1, b2, c1, c2, d1, d2
3.	Mid-Term Exam (Theory)	8th	15	7.5%	a1, a2, b1, b2, c1
4.	Mid-Term Exam (Practical) & the Projects Preparation and Presentations	7th & 14th	20	10%	a1, a2, b1, b2, c1, c2, d1, d2
5.	Final exam (Practical)	15th	25	12.5%	a1, b1, b2, c1,c2, d1
6.	Final Exam (Theory)	16th	100	50%	a1, a2, b1, b2, c1
	Total		**200**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 12th Edition, Prentice Hall,2013

2- Essential References.

1. Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Prentice Hall,2010

3- Electronic Materials and Web Sites *etc*.

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	1. http://www.sciencedirect.com/ 2. http://www.mathwork.com/ 3. http://www.matlab.com/ 4. http://dl.acm.org/dl.cfm 5. http://ieeexplore.ieee.org/Xplore/guesthome.jsp 6. http://www.emeraldinsight.com 7. http://www.scopus.com/home.url 8. http://link.springer.com/

IX. Course Policies:	
1.	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3.	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4.	**Assignments & Projects:** In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5.	**Cheating**: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6.	**Plagiarism**:

	Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Assoc. Prof. Dr. Farouk Al-Fuhaidy**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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