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DeCAIR Course Syllabus Form

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Organization Name(s)	The University of Jordan		
WP Number & Title	Work Package 6: Improving Existing B.Sc. Programs in Jordan and Lebanon by Implementing or Including AI and Robotics Courses		
Activity Number & Title	Task 6.1: Developing syllabi and content for added/modified courses in existing BSc programs in universities of partner countries		
WP Leader	Jorge Casillas, University of Granada		
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	8/11/2021	Adham Alsharkawi	Original (base) document	C	1-5
2	18/12/2021	Adham Alsharkawi	Original (Base) document	U	1-5
3					
4					

(*) Action: C = Creation, I = Insert, U = Update, R = Replace, D = Delete

Disclaimer

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<table>
<tr><td>Course title</td><td>Digital Control</td></tr>
<tr><td>Course number</td><td>0908483</td></tr>
<tr><td>Credit hours (lecture and lab)</td><td>3 (3 + 0)</td></tr>
<tr><td>ECTS (weekly contact and self-study load)</td><td>6 (3 + 3)</td></tr>
<tr><td>Prerequisites/co-requisites</td><td>0908382 (Control Systems), 0908371 (Engineering Measurements and Signal Processing)</td></tr>
<tr><td>Prerequisites by topic</td><td>Basics of analog control</td></tr>
<tr><td>Level and type (compulsory, elective)</td><td>BSc obligatory course</td></tr>
<tr><td>Year of study and semester</td><td>Fourth year, first semester</td></tr>
<tr><td>Description</td><td>This course introduces the fundamental concepts, principles and applications of digital control system analysis and design to undergraduate students. The course begins with an introduction to digital control and the reasons for its popularity. It then proceeds to consider discrete-time models and their analysis using the z-transform. Simple mathematical models for linear discrete-time systems are also derived in this course. Then, the course moves on to present stability tests for input-output systems. The course ends with the topic digital control design. This topic begins with proportional control design then examines digital controllers based on analog design. The direct design of digital controllers is considered next.</td></tr>
<tr><td>Objectives</td><td>1. Introduce students to the importance of digital control.
2. Introduce students to discrete-time systems.
3. Introduce students to modeling of digital control systems.
4. Introduce students to stability of digital control systems.
5. Introduce students to digital control system design.</td></tr>
<tr><td>Intended learning outcomes</td><td>Upon successful completion of this course, students will be able to:
<table>
<tr><th>No</th><th>Intended learning Outcome (ILO)</th><th>Program learning outcome (PLO)*</th></tr>
<tr><td>1</td><td>Acquire the basic knowledge of digital control</td><td>1</td></tr>
<tr><td>2</td><td>Demonstrate knowledge of discrete-time systems</td><td>2</td></tr>
<tr><td>3</td><td>Develop models of digital control systems</td><td>1</td></tr>
<tr><td>4</td><td>Analyze the stability of digital control systems</td><td>3</td></tr>
<tr><td>5</td><td>Assess digital control system design</td><td>4</td></tr>
</table>
(*) The PLOs are listed in the appendix</td></tr>
<tr><td>Teaching and learning methods</td><td>Development of ILOs is promoted through the following teaching and learning methods:</td></tr>
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Lectures will be delivered face to face and through Microsoft Teams and will be recorded for later access.
The control lab is open for the students to practice the practical aspects.
The student attends the class presentations and participates in the class discussions.
The student joins the related online team/group and participates in its discussions.
The student studies the reference material, including books and videos.
The student solves the control assignments using appropriate tools.
The student carries out a term project for solving a particular control problem.
The student develops a professional report for the term report.
The student presents the term project in class.

</td></tr>
<tr><td>Learning material</td><td>Textbook, class handouts, lecture notes, selected YouTube videos and recordings.</td></tr>
<tr><td>Resources and references</td><td>A- Required book(s), assigned reading and audio-visuals:

1. M. Sami Fadali, Antonio Visioli. Digital control engineering: analysis and design. 3rd Edition. 2019.

B- Recommended book(s), material and media:
1. Charles L. Phillips, H Troy Nagle, Aranya Chakrabortty. Digital Control System Analysis & Design. 4th Edition. 2014.</td></tr>
<tr><td>Topic outline and schedule</td><td>
<table>
<tr><th>Week</th><th>Topic</th><th>ILO</th><th>Resources</th></tr>
<tr><td>1-2</td><td>Introduction to Digital Control.</td><td>1</td><td>A-1, B-1</td></tr>
<tr><td></td><td>Why digital control?</td><td></td><td></td></tr>
<tr><td></td><td>The structure of a digital control system</td><td></td><td></td></tr>
<tr><td></td><td>Examples of digital control systems</td><td></td><td></td></tr>
<tr><td>3-6</td><td>Discrete-Time Systems</td><td>2</td><td>A-1, B-2</td></tr>
<tr><td></td><td>Analog systems with piecewise constant inputs</td><td></td><td></td></tr>
<tr><td></td><td>Difference equations</td><td></td><td></td></tr>
<tr><td></td><td>The z-transform</td><td></td><td></td></tr>
<tr><td></td><td>Computer-aided design</td><td></td><td></td></tr>
<tr><td></td><td>z-Transform solution of difference equations</td><td></td><td></td></tr>
<tr><td></td><td>The time response of a discrete-time system</td><td></td><td></td></tr>
<tr><td></td><td>The modified z-transform</td><td></td><td></td></tr>
<tr><td></td><td>Frequency response of discrete-time systems</td><td></td><td></td></tr>
<tr><td></td><td>The sampling theorem</td><td></td><td></td></tr>
<tr><td>7-10</td><td>Modeling of Digital Control Systems</td><td>3</td><td>A-1</td></tr>
<tr><td></td><td>ADC model</td><td></td><td></td></tr>
<tr><td></td><td>DAC model</td><td></td><td></td></tr>
<tr><td></td><td>The transfer function of the ZOH</td><td></td><td></td></tr>
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		Effect of the sampler on the transfer function of a cascade		
		DAC, analog subsystem, and ADC combination transfer function		
		Systems with transport lag		
		The closed-loop transfer function		
		Analog disturbances in a digital system		
		Steady-state error and error constants		
	11-12	**Stability of Digital Control Systems**	4	A-1, B-1
		Definitions of stability		
		Stable z-domain pole locations		
		Stability conditions		
		Stability determination		
		Jury test		
		Nyquist criterion		
	13-15	**Digital Control System Design**	5	A-1, B-1
		z-Domain root locus		
		z-Domain digital control system design		
		Digital implementation of analog controller design		
		Direct z-domain digital controller design		
		Frequency response design		
		Direct control design		
		Finite settling time design		

Evaluation tools

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:

Assessment tool	Mark	Topic(s)	Time
Assignments	5%	Stability of Digital Control Systems	W12
Midterm exam	30%	Introduction to Digital Control, Discrete-Time Systems, Modelling of Digital Control Systems	W8
Term project	15%	Digital Control System Design	W15
Final exam	50%	All Topics	W16
Total	**100%**		

Student requirements

Students should have access to a computer and internet connection.

Course policies

A- Attendance policies:

	• Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard. B- Absences from exams and submitting assignments on time: • A makeup exam can be arranged for students with acceptable absence causes. • Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty. • The project report must be handed in in time. C- Health and safety procedures: • All health and safety procedures of the university and the school should be followed. D- Honesty policy regarding cheating, plagiarism, misbehavior: • Open-book exams • All submitted work must be of the submitting student. • Other text or code must be properly quoted with clear source specification. • Cheating will not be tolerated. E- Available university services that support achievement in the course: • Microsoft Teams team and Moodle course page • AI Lab for practicing the practical aspects and solving the programming assignments. • Program announcements Facebook group
Additional information	None

Appendix

Learning Outcomes for the BSc in Mechatronics Engineering

Students who successfully complete the BSc in Mechatronics Engineering will be able to:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.