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	1-6
2	9th Dec. 2021	Ashraf Suyyagh	Modified document	R	1-6
3					
4					

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

Disclaimer

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Course title	Computer Control Systems
Course number	0917433
Credit hours (lecture and lab)	3 (3 + 0)
ECTS (weekly contact and self-study load)	7 (2 + 5) The course will be offered as a blended course where there are two weekly in-person contact hours, and one hour for activities, projects, guided exercises, etc.
Prerequisites/co-requisites	Embedded Systems Lab (0907334) + Signals Analysis and Systems (0953221)
Prerequisites by topic	Students are required to have good understanding of embedded systems design concepts and programming, as well as good knowledge of linear continuous and discrete time systems. Basic knowledge in MATLAB is preferable.
Level and type (compulsory, elective)	BSc compulsory course
Year of study and semester	Fourth Year – First Semester
Description	The undergraduate course introduces students to the **basic** concepts of continuous/digital open-loop and closed-loop feedback systems, and system modelling using Laplace and Z-transforms. Students will learn about a system's transfer function, block diagram model reduction, and the transfer's function zeros, poles, and stability analysis. The course will cover the unit and impulse response of first and second order control systems as well as a brief introduction to PID controllers. The course will use Simulink to allow students to build and analyze a simple control system. The course will also introduce practical considerations in control systems design: ADCs and DACs, control timeliness (hard/soft), sampling frequency (Nyquist/Shannon/Aliasing/jittering and its effects), choosing suitable sensors per application, actuators, advanced interfacing, signal conditioning and filtering (FIR, IIR, 1D Kalman), sources of error (quantization, fixed-point vs. floating point tradeoffs, controller architecture), choosing the correct controller, control system safety, fault-tolerance, and scalability. Finally, the course introduces DSP libraries and control blocks as well as the basics of real-time control systems programming based on ARM Cortex-M and Cortex-R as a case-study.
Objectives	1. Introduce students to the fundamentals of open-loop and closed-loop feedback control systems. 2. Introduce the students to the basic concepts of system modelling, Laplace and Z-transforms, and transfer functions. 3. Introduce students to the techniques that analyze system stability, and its response to impulse and unit functions and the design of PID controllers.

<table>
<tr><td></td><td>4. Enable students to understand and analyze the functional, temporal, and non-functional requirements of a control system and enable them to make sound decisions regarding practical considerations in designing and implementing control systems.
5. Introduce students to the basics of control system programming and the use of specialized DSP and control libraries.</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>Demonstrate sound understanding of the basic principles of computer-controlled systems and be able to design and analyze practical systems</td><td>1</td></tr>
<tr><td>2</td><td>Use C/C++ and specialized DSP libraries/APIs, to develop control software</td><td>2</td></tr>
<tr><td>3</td><td>Communicate the process of designing a control system or recent advances related to computer control systems through a report</td><td>3</td></tr>
<tr><td>4</td><td>The ability to conduct proper analysis and experimentation in the hardware and software design of a computer controlled system</td><td>6</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:
• The School of Engineering and the computer engineering department labs are open for the students to practice the practical aspects and solve the Simulink and programming homework / project assignments.
• The student attends the class presentations and participates in the discussions.
• The student joins the related online team/group and participates in its discussions.
• The student studies the reference material, including books, APIs, and videos.
• The student studies and understands the designated self-study material and solves relevant exercises to check their understanding.
• The student solves the assignments related to control system design and analysis.
• The student carries out a term project programming a control system or designing one using MATLAB Simulink or both
• The student develops a professional report about recent advances and topics related to control systems for the term report.</td></tr>
<tr><td>Learning material</td><td>Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.</td></tr>
</table>

Resources and references

Required book(s), assigned reading and audio-visuals:

1. Computer Controlled Systems: Theory and Applications. G. Perdikaris, Springer.
2. ARM CMSIS and DSP APIs
3. MATLAB and Simulink help and documentation
4. Modern Control Systems, Dorf and Bishop, 13th Edition, 2017, Pearson Hall
5. Embedded Control System Design – A model based approach, Alexandru Forrai, Springer, 2013

Recommended book(s), material and media:

6. K. Ogata, "Modern Control Engineering", 5th Edition, 2010, Pearson Hall
7. Harder et al. "A practical Introduction to Real-Time Systems for Undergraduate Engineering", University of Waterloo, 2018 Available for free on authors' website.
8. Qing Li and Caroline Yao, "Real-Time Concepts for Embedded Systems", 2003
9. Cottet et al, "Scheduling in Real-Time Systems", 2002, Wiley and Sons.
10. Digital Control Engineering – Analysis and Design, 2nd Edition, Fadali and Visiolo, Elsevier, 2013

Topic outline and schedule

Week	Topic	ILO	Resources
1	Introduction to control systems, review of linear continuous and discrete-time systems and system modelling	1	1, 3, 4
2	Laplace and Z-Transforms and more on system modeling and the transfer function	1	1, 3, 4
3	Model reduction using mathematical and block-reduction methods	1	1, 3, 4
4	Analysis of system's poles, zeros, and basics of stability	1	1, 3, 4
5	Unit and impulse response of first and second order control systems	1	1, 3, 4
6	Introduction to PID controllers	1	1, 3, 4
7	Functional, temporal, and non-functional requirements of computer control systems	1, 3	Various
8	Advanced Interfacing of sensors and actuators	1,2,6	Various
9	Advanced topics on ADC and DAC and practical considerations	1,2,6	Various
10	Design and programming of signal noise filters in SW	2,6	2
11	Practical considerations in choosing the computer controller	1	Various

	12	DSP and control libraries, Controller Programming	2	2
	13	DSP and control libraries, Controller Programming	2	2
	14	DSP and control libraries, Controller Programming	2	2

Evaluation tools

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

Assessment tool	Mark	Topic(s)	Time
Homework assignment(s)	10%	Control System Design or programming	W2 – W12
Simulink or Programming Project	10%	Control System Design or programming	W2 - W12
Midterm exam	10%	Introduction through PIDs	W8
Term project report and/or presentation	30%	Practical and communication aspects	W15
Final exam	40%	All material	W16
Total	**100%**		

Student requirements

The student should have 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 an incremental penalty of 10% per day capped at 50%.
- The project report must be handed on 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 (students can access all necessary mathematical tables, APIs, MATLAB and Simulink Help, and selected course material)
- 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 • The School of Engineering has six labs with licensed MATLAB/Simulink software alongside selected packages
Additional information	None

Appendix

Learning Outcomes for the BSc in Computer Engineering

Students who successfully complete the BSc in Computer 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