DeCAIR Course Syllabus Form

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Organization Name(s)	Lebanese University		
WP Number & Title	Work Package 5: Improving Existing M.Sc. Programs in Jordan and Lebanon by Implementing or Including AI and Robotics Courses		
Activity Number & Title	Task 5.1: Developing syllabi and content for added/modified courses in existing master programs in universities of partner countries		
WP Leader	Peter Eberhard, University of Stuttgart		
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	1/8/2021	Clovis Francis	Master RSI Updated Courses Syllabus	C	1-6
2	22/10/2021	Clovis Francis	Version 2	U	
3	1/11/2021	Clovis Francis	Version 3		
4					

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

Disclaimer

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Course title	Modeling, Identification, observation and control of dynamics systems
Course number	RSI03
Credit hours (lecture and lab)	
ECTS (weekly contact and self-study load)	5 (total of 30 contact hours)
Prerequisites/co-requisites	Continuous and discrete automatic Control, continuous and discrete signal processing.
Prerequisites by topic	Students are assumed to have good background in mathematics and signal processing, particularly in calculus, linear algebra, statistics, and probability. Students are expected to have good knowledge in systems state space and transfer function representations in both continuous and discrete spaces. Additionally, the students should have good programming skills, preferably, using Matlab Simulink and Python.
Level and type (compulsory, elective)	Masters' compulsory course
Year of study and semester	Year 2, first semester
Description	After having presented the fundamental notions of the modelling of dynamic systems, this course presents the concepts of identification of the systems parameters in time and frequency domains. Parametric (ARX family) and nonparametric Identification of dynamics systems are also addressed in this course. The Least square estimate is presented to achieve the best fitting of measured data. The control part of this course introduces some state-of-the-art advanced control topics including Feedforward control, Lyapunov control design, Sliding Mode Control and Backstepping control.
Objectives	1. Introduce students to the techniques used in identification of dynamical systems including parametric and non-parametric methods. 2. Introduce students to the techniques used in advanced control of dynamic systems and especially nonlinear systems. 3. Introduce students to the synthesis techniques of linear am nonlinear observers 4. Introduce students to the programming techniques and libraries used in Identification.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

<table>
<tr><td></td><td>
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<tr><th>No</th><th>Intended learning Outcome (ILO)</th><th>Program learning outcome (PLO)*</th></tr>
<tr><td>1</td><td>Demonstrate a sound understanding of the main areas of Artificial Intelligence and Robotics (AIR) including dynamics systems modelling, identification and control</td><td>1</td></tr>
<tr><td>2</td><td>Solve an identification and control problem by developing an appropriate experimental system.</td><td>3</td></tr>
<tr><td>3</td><td>Communicate the development of a Control and identification of dynamics systems through a detailed technical report and a short presentation.</td><td>4</td></tr>
<tr><td>4</td><td>Use Matlab and its specialized libraries to develop programs for solving identification and control problems.</td><td>3</td></tr>
<tr><td>5</td><td></td><td></td></tr>
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(*) 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:
• Lectures will be delivered through Microsoft Teams/ZOOM and will be recorded for later access. Lectures could be offered in class if the situation allows it.
• The Control lab is open for the students to practice the practical aspects and solve the programming homework 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 and videos.
• The student solves the programming assignments in identification, observation and control.
• The student carries out a term project for solving a problem using identification and control techniques.
• 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, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.</td></tr>
<tr><td>Resources and references</td><td>Recommended book(s), material and media:
1. Lecture notes prepared by the Instructor
2. Hassan Khalil, Nonlinear Systems, 3rd Edition, Prentice Hall, 2001.
3. J.J. Slotine and W. Li, Applied Nonlinear Control, Prentice Hall, 1991.
4. Identification of Physical Systems by Rajamani Doraiswami · Chris Diduch · Maryhelen Stevenson, WILEY, 2014</td></tr>
</table>

5. MatLab System Identification toolbox user guide: https://au.mathworks.com/help/ident/getting-started-1.html
6. Control of Robot Manipulators in Joint Space, R. Kelly, V. Santibanez, A. Loria, Springer 2005

Topic outline and schedule

Lecture	Topic	Hours	ILO	Resources
1	Signal processing tools for identification	2	1	1,4
2	Identification toolbox of Matlab	2	4	1,4,5
3	Non parametric identification in the frequency and the time domains	3	1, 2, 4	1,4
4	Linear regression and least square estimate	3	1, 2, 4	1,4
5	Model parameters estimation	3	1, 2	1,4
6	Case study	2	5	1,4
7	Introduction to Feedforward Control	3	1	1,2,3
8	Lyapunov Control Design	3	1, 2	1,2,3
9	Sliding Mode Control	3	1, 2	1,2,3
10	Backstepping Control	3	1, 2	1,2,3
11	Applications and case studies	3	5	1,2,3,6

Evaluation tools

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

Assessment tool	Mark	Topic(s)	Time
Term project report and presentation in identification	50%	Programming of identification techniques	W10
Term project report and presentation in control	50%	Programming of control and observation techniques	W15
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 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 • Control Lab for practicing the practical aspects and solving the programming assignments.
Additional information	None

Appendix

Learning Outcomes for the MSc in Artificial Intelligence and Robotics

Students who successfully complete the MSc in Artificial Intelligence and Robotics (AIR) will be able to:

1. Demonstrate a sound understanding of the main areas of AIR including artificial neural networks, machine learning, data science, industrial and service robots, and intelligent and autonomous robots.

2. Apply a critical understanding of essential concepts, principles and practices of AIR, and critically evaluate tools, techniques and results using structured arguments based on subject knowledge.

3. Apply the methods and techniques of the AIR fields in the design, analysis and deployment of AIR solutions and solving practical problems.

4. Demonstrate the ability to produce a substantial piece of research work from problem inception to implementation, documentation and presentation.

5. Demonstrate life-long learning, independent self-learning and continuous professional development skills in the AIR fields.

6. Demonstrate a sound understanding of the ethical, safety and social impact issues of AIR solutions and products.