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	Musa Al-Yaman	Original (base) document	C	1-5
2	Dec 19, 2021	Mohammad Mashagbeh	Original (base) document	U	1-5
3					
4					

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

Disclaimer

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Course title	Robotic Systems
Course number	0908563
Credit hours (lecture and lab)	3 (3 + 0)
ECTS (weekly contact and self-study load)	6 (3 + 3)
Prerequisites/co-requisites	Engineering Numerical Methods (0908311)
Prerequisites by topic	Students are assumed to have sufficient knowledge pertaining to the following: Numerical methods, Linear Algebra, Systems dynamics, Machinery and Matlab computer language.
Level and type (compulsory, elective)	BSc mandatory course
Year of study and semester	Fifth year, first semester
Description	Introduction and an overview of robot types, basic components of industrial manipulators, coordinate frames, homogeneous transformations, forward and inverse kinematic of industrial manipulators, differential kinematics, Jacobian and singularity, manipulator dynamics, force and torque transformation, trajectory planning, and MATLAB Programming.
Objectives	1. Learn the fundamental concepts of robotics manipulation such as transformation mathematics in 3D space, forward kinematics, inverse kinematics, Jacobian and singularities, manipulator dynamics, and trajectory planning. 2. Use computer languages such as MATLAB to solve course topics in a generalized procedure using symbolic manipulation and numerical techniques.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	Program learning outcome (PLO)*
1	Demonstrate a sound understanding of the main concepts and components of robotic systems.	1
2	Calculate rotation matrix, and the homogenous transformation.	2
3	Determine forward kinematics, inverse kinematics, and differential kinematics of industrial manipulators.	3
4	Find the dynamic equations and the trajectory planning of industrial manipulators.	4
5	Use MATLAB and its specialized toolboxes to analyze industrial manipulators.	4

<table>
<tr><td></td><td>(*) 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 in person and through Microsoft Teams and will be recorded for later access.
The robotics lab is open for the students to practice the practical aspects and solve the 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 assignments in robotics field.
Student will carry out a term project in groups. Deliverables includes a professional report and a presentation for the project in class towards end of the semester.</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>A- Required book(s), assigned reading and audio-visuals:
B. Siciliano et. al., Robotics – Modeling, Planning and Control, Springer, 2009.
B- Recommended book(s), material and media:<ol start="2">
Introduction to Robotics: Mechanics and Control by John J. Craig. Pearson; 4th edition (February 23, 2017)
Robot Modeling and Control; by Mark W. Spong, Seth Andrew Hutchinson, M. Vidyasagar. Wiley; 2nd edition (February 25, 2020)
Introduction to Robotics: Analysis, Control, Applications, by Saeed B. Niku. Wiley; 3rd edition (December 17, 2019)</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</td><td>Introduction to Robotics</td><td>1</td><td>1, 2</td></tr>
<tr><td>2-3</td><td>Spatial Description and Transformation</td><td>2</td><td>1,3</td></tr>
<tr><td>4-5</td><td>Forward Kinematics of Industrial Manipulator</td><td>2, 3, 5</td><td>1,2,3</td></tr>
<tr><td>6-7</td><td>Inverse Kinematics of Industrial Manipulator</td><td>2, 3, 5</td><td>1,2,3</td></tr>
<tr><td>8-9</td><td>Differential Kinematics</td><td>3, 5</td><td>1,4</td></tr>
<tr><td>10-11</td><td>Dynamics of Rigid Bodies</td><td>4,5</td><td>1,2</td></tr>
<tr><td>12-13</td><td>Trajectory planning</td><td>4,5</td><td>1,2,4</td></tr>
<tr><td>14</td><td>MATLAB Programming</td><td>5</td><td>1,2,3,4</td></tr>
<tr><td>15</td><td>Term Project Presentations</td><td>1-5</td><td>1,2,3,4</td></tr>
</table></td></tr>
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<table>
<tr><td>Evaluation tools</td><td>Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:
<table>
<tr><th>Assessment tool</th><th>Mark</th><th>Topic(s)</th><th>Time</th></tr>
<tr><td>Homework assignments</td><td>10%</td><td>Programming aspects</td><td>W2-W14</td></tr>
<tr><td>Midterm exam</td><td>30%</td><td>Introduction through Inverse Kinematics of Industrial Manipulator</td><td>W8</td></tr>
<tr><td>Term project report and presentation</td><td>20%</td><td>Practical and presentation aspects</td><td>W15</td></tr>
<tr><td>Final exam</td><td>40%</td><td>All material</td><td>W16</td></tr>
<tr><td>Total</td><td>100%</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Student requirements</td><td>The student should have a computer and internet connection.</td></tr>
<tr><td>Course policies</td><td>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
Robotics Lab for practicing the practical aspects and solving the assignments.
Program announcements Facebook group</td></tr>
<tr><td>Additional information</td><td>None</td></tr>
</table>

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.