Sana'a University
Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

66. Elective 2

Course Specification of Introduction to Robotics

I. Course Identification and General Information:						
1.	Course Title:	Introduction to Robotics (Elective Course)				
2.	Course Code & Number:	ME328				
3.	Credit hours:	C.H				TOTAL CR. Hrs.
		Th.	Seminar/Tu	Pr	Tr.	
		2	--	--	--	2
4.	Study level/ semester at which this course is offered:	Fourth Year- Second Semester				
5.	Pre –requisite (if any):	Technical Writing, Engineering Mechanics – Statics , Mechanics of Machines.				
6.	Co –requisite (if any):	None				
7.	Program (s) in which the course is offered:	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	Location of teaching the course:	Mechanical Engineering Department.				
10.	Prepared By:	Asst. Prof. Dr. Hatem Al-Dois.				
11.	Date of Approval:					

II. Course Description:

This course is an introductory course to robotics. Students in this course will learn robot terminology, different types and configurations of robots, structure and main components, essential concepts and skills of programming and control, and applications of robots. Proper robot safety procedures will be emphasized throughout the study. The course is examined with assignments, quizzes, mid and final exams.

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III. Alignment course intended learning outcomes (CILOs)		Referenced PILOs
a1	Outline systematically the structure of a robotic manipulator and the operation of its main components.	**A1** Demonstrate knowledge & understanding of Mathematics, Science, and Engineering relevant to Mechanical Engineering.
a2	Identify safety considerations during installation, maintenance, programming, automatic operations of robotic systems.	**A.3** Explain the principles of different mechanical systems and their effects on global environment and societal contexts.
b1	Locate the main components of the robot including the controller, manipulator arm, teach pendant, standard operator panel, sensors, actuators, and end-of-arm-tooling or vacuum components.	**B1** Apply the principles of engineering, basic science and mathematics to model, analyze, design, and realize physical systems, components or processes in innovative ways.
b2	Classify robotic systems according to their application, control system, arm geometry, actuators and sensors used, and end-of-arm tooling.	**B2** Design the Mechanical systems or processes within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
c1	Write programs to perform various complex tasks and motions of robotic systems.	**C1** Use the various techniques, skills, equipment and modern engineering tools and methods necessary for Mechanical Engineering practice.
d1	Search the literature for different information related to the given assignments in robotics.	**D.4** Perform searches of literature, use databases, as well as, evaluate information and evidence from various sources.

(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- Outline systematically the structure and the operation of its main components of a robotic manipulator.	Lectures, Seminars	Examinations, Homework and Assignments, Presentations
a2- Identify safety considerations during installation, maintenance, programming, automatic operations of robotic systems.	Lectures, Seminars, Interactive Class Discussions	Examinations, Homework and Assignments, Presentations

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Locate the main components of the robot including the controller, manipulator arm, teach pendant, standard operator panel, sensors, actuators, and end-of-arm-tooling or vacuum components.	Lectures, Seminars, Interactive Class Discussions	Examinations, Homework and Assignments, Presentations
b2- Classify robotic systems according to arm used, their application, control system, geometry, actuators and sensors and end-of-arm tooling.	Lectures, Seminars, Interactive Class Discussions	Examinations, Homework and Assignments, Presentations

(C) 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- Write programs to perform various complex tasks and motions of robotic systems.	Lectures, Seminars, Directed self- study	Examinations, Homework and Assignments, Presentations

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Search the literature for different information related to the given assignments in robotics.	Seminars, Assignments	Homework and Assignments, Presentations

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction	a1	– What is a Robot? – What is Robotics? – History of Robotics. – Advantages and Disadvantages of Robots – Robot Degrees of Freedom. – Mass Production and Batch Manufacturing – Flexible Manufacturing Systems – Robotic Safety	1	2
2.	Robots Components and Specifications	a1, b1, b2	– Basic Components of Robot Systems – Manipulator Geometry – Wrists – End Effectors – Robot Workspace – Classifying Robots by Drive Control Systems	2	4

			– Classifying Robots by Teaching Methods – Specifying Robot By Repeatability, Precision, Accuracy		
3.	Robots Classifications	a1, b2	– Robot Classification – Control Systems – Open-loop/Closed-loop – Advantages/Disadvantages – Applications/Operations – Advantages/Disadvantages – Power Sources – Continuous-path Vs. Point-to-point Control	2	4
4.	Robot Geometry	b1, b2	– Rectangular Geometry – Cylindrical Geometry – Spherical Geometry – Jointed-spherical Geometry	1	2
5.	Sensors for Robotics	a1, a2, b1, b2, d1	– Sensors Overview – Contact Sensors – Noncontact Sensors – Photoelectric – Proximity – Simple Process Sensors – Complex Process Sensors	1	2
6.	Mid-Term Exam	a1, a2, b1, b2	– The First 5 Chapters.	1	2
7.	Actuators for Robotics	a1, a2, b1, b2, d1	– Electrical Actuators – DC Motors – AC Motors – Stepper Motors – Servo Motors	1	2

			– Hydraulic Actuators – Pneumatic Actuators		
8.	End-of-Arm Tooling	a1, b1, b2, d1	– Terms – Power Sources – Standard Grippers: Angular, Parallel – Internal-external Gripping – Vacuum, Magnetic, Flexible, Special Purpose	1	2
9.	Introduction to Robotics Programming	a2, c1	– Basic concepts of programming – Introduction to the programming environment, tools and basic commands of robotics platforms – Elements of a Robot Program – Program Commands – Arm Motion – Task Point Diagram – Online-offline Programming	2	4
10.	Robot Safety	a2, d1	– Robots Require Respect (3Rs) – People dealing with robots	1	2
11.	Presentation	a1, a2, b1, b2, c1, d1	– Related Topics	2	4
12.	Final Exam	a1, a2, b1, b2	All Topics	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

V. Teaching strategies of the course:

- Lectures,
- Seminars,
- Interactive Class Discussions

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- Directed self- study
- Assignments

VI. Assessment methods of the course:

- Examinations
- Homework and Assignments
- Presentations

VII. Assignments:

No.	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1	Robots Applications	b2, d1	2nd week	2
2	Most-Known Configurations of Industrial Robots	a1, b2, d1	4th week	2
3	Actuators used for Industrial Robots	a2, b1, b2, d1	6th week	2
4	Sensors used for Industrial and Non-Industrial Robots	a2, b1, b2, d1	8th week	2
5	Programming and Control of Industrial Robots	a2, b1, b2, c1, d1	10th week	2
6	Robot Safety	a2, d1	12th week	2
Total				**12**

VIII. 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	3rd , 9th, 11th , 13th weeks	8	8 %	a1, a2
2	Assignments	2nd, 4th, 6th, 8th, 10th, 12th weeks	12	12 %	a1, a2, b1, b2, c1, d1
3	Mid-Term Exam	8th week	20	20 %	a1, a2, b1, b2

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4	Final Exam	16th week	60	60 %	a1, a2, b1, b2
Total			**100**	**100 %**	

IX. Learning Resources:

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

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

1. Groover, M. P., Weiss, M., Nagel, R. N., and Odrey, N. G. , 1986, Industrial Robotics, Technology, Programming, and Applications. New Delhi: McGraw-Hill.
2. Saeed Niku, 2002, Introduction to Robotics: Analysis, Systems, Applications, 1st Edition, NJ, Prentice Hall.

2- Essential References.

1. Spong, M. W., & Vidyasagar, M., 2004, Robot Dynamics and Control, NY, Wiley.
2. Mittal, R. K., & Nagrath, I. J., 2008, Robotics and Control. New Delhi, India: Tata McGraw-Hill.
3. Lung-S-Wen Tsai, 1999, Robot Analysis, NY, John Wiley & Sons, Inc.
4. K.S. Fu, R.C. Gonzalez, and C.S.G. Lee, 1987, Robotics: Control, Sensing, Vision and Intelligence, NY, McGrawHill.
5. H.Asada and J. Slotive, 1986, Robot Analysis and Control, NY, John Wiley & Sons.
6. Lynch and Park, 2017, Modern Robotics, Cambridge, Cambridge University Press.
7. Thrun, Burgard, and Fox, 2005, Probabilistic Robotics, USA, MIT Press.

3- Electronic Materials and Web Sites *etc.*

1. Teaching ROBOTC for Innovation First Robots, Carnegie Mellon Robotics Academy. http://www.robotc.net/vex_full/.
2. Introduction to Robotics Course (2DD2410) - KTH https://www.kth.se/social/course/DD2410/
3. Modern Robotics, Lynch and Park, Cambridge University Press, 2017, authors' site (free version, video lectures): http://lynchandpark.org

	4. Probabilistic Robotics, Thrun, Burgard, and Fox, MIT Press, 2005, authors' site http://www.probabilistic-robotics.org/

X. Course Policies:

1.	**Class Attendance:** The students should have more than 75 % of attendance according to rules and regulations of the Faculty.
2.	**Tardy:** The students should respect the timing of attending the lectures. They should attend within 10 minutes from starting of the lecture.
3.	**Exam Attendance/Punctuality:** The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
4.	**Assignments & Projects:** The assignment is given to the students after each chapter, the student has to submit all the assignments for checking on time.
5.	**Cheating**: If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries.
6.	**Plagiarism**: The student will be terminated from the Faculty, if one student attends the exam on another behalf according to the policy, rules and regulations of the university.
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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. Khalil Al-Hatab**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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66. Course Plan of Introduction to Robotics

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Dr. Hatem Al-Dois	**Office Hours**					
Location& Telephone No.	Department of Electrical Engineering, Ibb University	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	haldois@yahoo.com						

II. Course Identification and General Information:

1.	Course Title:	Introduction to Robotics (Elective Course).				
2.	Course Number & Code:	ME328.				
3.	Credit hours:	C.H				TOTAL CR. Hrs.
		Th.	Seminar/Tu	Pr	Tr.	
		2	--	--	--	2
4.	Study level/year at which this course is offered:	Fourth Year- Second Semester.				
5.	Pre –requisite (if any):	Technical Writing ,Engineering Mechanics – Statics , Mechanics of Machines.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	System of Study:	Semesters.				
10.	Mode of delivery:	Lectures.				
11.	Location of teaching the course:	Mechanical Engineering Department.				

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III. Course Description:

This course is an introductory course to robotics. Students in this course will learn robot terminology, different types and configurations of robots, structure and main components, essential concepts and skills of programming and control, and applications of robots. Proper robot safety procedures will be emphasized throughout the study. The course is examined with assignments, quizzes, mid and final exams.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1- Outline systematically the structure of a robotic manipulator and the operation of its main components.

2- Identify safety considerations during installation, maintenance, programming, automatic operations of robotic systems.

3- Locate and identify the main components of the robot including the controller, manipulator arm, teach pendant, standard operator panel, sensors, actuators, and end-of-arm-tooling or vacuum components.

4- Classify robotic systems according to their application, control system, arm geometry, actuators and sensors used, and end-of-arm tooling.

5- Write programs to perform various complex tasks and motions of robotic systems.

6- Search the literature for different information related to the given assignments in robotics.

V. Course Content:

- Distribution of Semester Weekly Plan Of course Topics/Items and Activities.

A – Theoretical Aspect:

Order	Topics List	Sub Topics List	Week Due	Contact Hours
1.	Introduction	– What is a Robot? – What is Robotics? – History of Robotics. – Advantages and Disadvantages of Robots – Robot Degrees of Freedom. – Mass Production and Batch Manufacturing – Flexible Manufacturing Systems – Robotic Safety	1st week	2
2.	Robots Components and Specifications	– Basic Components of Robot Systems – Manipulator Geometry – Wrists – End Effectors – Robot Workspace – Classifying Robots by Drive Control Systems – Classifying Robots by Teaching Methods – Specifying Robot By Repeatability, Precision, Accuracy	2nd & 3rd weeks	4
3.	Robots Classifications	– Robot Classification – Control Systems – Open-loop/Closed-loop – Advantages/Disadvantages – Applications/Operations	4th & 5th weeks	4

		– Advantages/Disadvantages – Power Sources – Continuous-path Vs. Point-to-point Control		
4.	Robot Geometry	– Rectangular Geometry – Cylindrical Geometry – Spherical Geometry – Jointed-spherical Geometry	6th week	2
5.	Sensors for Robotics	– Sensors Overview – Contact Sensors – Noncontact Sensors – Photoelectric – Proximity – Simple Process Sensors – Complex Process Sensors	7th week	2
6.	Mid-Term Exam	– The First 5 Chapters.	8th week	2
7.	Actuators for Robotics	– Electrical Actuators – DC Motors – AC Motors – Stepper Motors – Servo Motors – Hydraulic Actuators – Pneumatic Actuators	9th week	2
8.	End-of-Arm Tooling	– Terms – Power Sources – Standard Grippers: Angular, Parallel – Internal-external Gripping	10th week	2

		– Vacuum, Magnetic, Flexible, Special Purpose		
9.	Introduction to Robotics Programming	– Basic concepts of programming – Introduction to the programming environment, tools and basic commands of robotics platforms – Elements of a Robot Program – Program Commands – Arm Motion – Task Point Diagram – Online-offline Programming	11th & 12th weeks	4
10.	Robot Safety	– Robots Require Respect (3Rs) – People dealing with robots	13th week	2
11.	Presentation	– Related Topics	14th & 15th weeks	4
12.	Final Exam	All Topics	16th week	2
Number of Weeks /and Units Per Semester			**16**	**32**

VI. Teaching strategies of the course:

- Lectures,
- Seminars,
- Interactive Class Discussions
- Directed self- study
- Assignments

VII. Assessment methods of the course:

- Examinations
- Homework and Assignments
- Presentations

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VIII. Assignments:

No.	Assignments	Week Due	Mark
1	Robots Applications	2nd week	2
2	Most-Known Configurations of Industrial Robots	4th week	2
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4	Sensors used for Industrial and Non-Industrial Robots	8th week	2
5	Programming and Control of Industrial Robots	10th week	2
6	Robot Safety	12th week	2
Total			**12**

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

Assessment	Type of Assessment Tasks	Week Due	Mark	Proportion of Final Assessment
1	Quizzes	3rd , 9th, 11th , 13th weeks	8	8 %
2	Assignments	2nd, 4th, 6th, 8th, 10th, 12th weeks	12	12 %
3	Mid-Term Exam	8th week	20	20 %
4	Final Exam	14th week	60	60 %
Total			**100**	**100%**

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