49. Course Specification of Robotics

I.Course Identification and General Information:

.1	Course Title:	Robotics.				
.2	Course Code & Number:	MT311.				
.3	Credit Hours:	C.H.				TOTAL CR.HR
		Th.	Seminar	Pr.	Tu.	
		2	-	2	2	4
.4	Study Level/ Semester at which this Course is offered:	Fourth Year - Second Semester.				
.5	Pre –Requisite (if any):	Design of Machine Elements, Digital Control System, Embedded Systems and Interfacing and Industrial Automation.				
.6	Co –Requisite (if any):	None.				
7.	Program (s) in which the Course is offered:	Mechatronics Engineering Program.				
.8	Language of Teaching the Course:	English Language.				
.9	Location of Teaching the Course:	Mechatronics Engineering Department.				
.10	Prepared by:	Asst. Prof. Dr. Hatem Al-Dois.				
11.	Date of Approval:					

II.Course Description:

This course provides students with essential knowledge and foundation of robotics. The contents of the course are distributed into six main topics: description of position and orientation; robot's forward and inverse kinematics; robot dynamics, differential motions and Jacobian; trajectory planning; and robot control systems. Tutorial classes are provided to support the foundation concepts given in theoretical classes through a variety of design problems. In practical sessions, students learn different computer tools for robot design and analysis such as: Robotics Toolbox for Matlab, Robot Studio, and ROS. In addition, the course includes a group-based term project in which students will design and fabricate working robotic systems.

III.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Characterize knowledge of robot's different structures, forward and inverse kinematics, dynamics, trajectory planning, and control methods.	A1

a2.	List different robot design configurations for various industrial and non-industrial applications.	A2
b1.	Formulate solutions to common mechatronics problems using robotic systems with suitable hardware and software components.	B1
b2.	Analyze results of different simulation tools for different robot mechanisms, kinematic and dynamic models, motion profiles, and control schemes of robotic manipulators.	B2
c1.	Practice different modeling, simulation and analyses software of robot manipulators performance for various applications.	C2
c2.	Employ suitable hardware and software components for useful robotic manipulator designs in a given task.	C3
d1.	Cooperate effectively in work as a part of a team during the design and implementation of the project and assignment works.	D1
d2.	Review effective technical reports and project presentations during lab sessions and term-project in robotics.	D6

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes		Teaching Srategies	Assessment Strategies
Characterize knowledge of different structures, robot's inverse kinematics, forward and trajectory planning, dynamics, and control methods.	**a1.**	• Active Lectures. • Tutorials.	• Written Assessment. • Short Essays. • Presentations. • Simulations.
List different robot design configurations for various and non-industrial industrial applications.	**a2.**	• Active Lectures. • Tutorials. • Independent Learning.	• Written Assessment. • Presentations. • Simulations.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
Formulate solutions to common mechatronics problems using robotic systems with suitable hardware and software components.	**b1.**	• Design Work and Project. • Case Studies.	• Written Assessments. • Practical Assessment. • Laboratory Reports.
Analyze results of different simulation tools for different	**b2.**	• The use of Communication and	• Written Assessments. • Practical Assessment.

mechanisms, kinematic robot and dynamic models, motion profiles, and control schemes of robotic manipulators.	Information Technology. • Case Studies.	• Laboratory Reports. • Project Reports.

(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. Practice different modeling, simulation and analyses software of robot performance manipulators for various applications.	• Problem-Based Learning. • Hands-on Laboratory Work. • Computer-Based Learning.	• Simulations.
c2. Employ suitable hardware and software components for robotic manipulator useful designs in a given task.	• Hands-on Laboratory Work. • Computer-Based Learning. • Case Studies. • Design Work and Projects.	• Practical Assessment. • Simulations. • Laboratory Reports. • 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. Cooperate effectively in as a part of a team work during the design and implementation of the project and assignment works.	• Group Learning and Problem-Based Learning. • Design Work and Projects.	• Project Reports.
d2. Review effective technical reports and project presentations during lab sessions and term-project in robotics.	• Laboratory Work. • Presentations. • Design Work and Projects.	• Laboratory Reports. • Presentations.

IV.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Fundamentals.	a1, a2	• Robotics Definitions, Classification, History, Advantages and Disadvantages, DoFs, Components, and Applications. • Robot Reference Frames and Coordinates. • Robot Languages and • Programming Modes.	2	4
2.	Robot Kinematics.	a1, a2	• Description of Position and Orientation. • Denavit-Hartenberg Convention of Forward Kinematics. • The Inverse Kinematic Solutions. • Degeneracy and Dexterity. • Computational Considerations.	2	4
3.	Differential Motions and Velocities.	a1, a2, b1, b2	• Differential Motions of a Frame. • Differential Relationships of Velocities. • Calculation of the Jacobian. • Jacobian in Different Frames. • Jacobian in the Force Domain/ • Singularity. • Jacobian in the Cartesian Space.	2	4
4.	Mid-Term Exam.	a1, a2, b1, b2	• The First 3 Chapters.	1	2
5.	Dynamic Analysis and Forces.	a1, b1, b2	• Newton and Lagrangian Mechanics. • Transformation of Forces and Moments between Coordinate Frames.	2	4

			• Dynamic Equations for Multiple-DoF Robots. • Structure of Robot Dynamics Equation. • Newton-Euler Vs. Lagrange Euler Equations of Robots Motion. • Static Force Analysis of Robots. • Robots Dynamics in Cartesian Space.		
6.	Trajectory Planning.	a1	• Basics of Trajectory Planning. Path Vs. Trajectory. • Joint Space Vs. Cartesian-Space Trajectories. • Cubic, Quantic, Trapezoidal, and Linear Segments with Parabolic Blends Trajectories. • Collision-Free Path Planning.	1	2
7.	Linear Control of Manipulators.	a1, b1, b2	• Feedback and Closed-Loop Control. • Control of Second-Order Systems. • Control-Law Partitioning. • Trajectory-Following Control • Disturbance Rejection. • Continuous Vs. Discrete Time Control. • Independent Joint Control System. • Modeling and Control of a Single Joint. • Architecture of an Industrial-Robot Controller.	2	4
8.	Nonlinear Control of Manipulators.	a1, b1, b2	• Nonlinear and Time-Varying Systems. • Multi-Input, Multi-Output Control Systems. • The Control Problem for Manipulators. • Model-Based Control System.	2	4

			• Feed-Forward Control System. • Practical Considerations. • Current Industrial-Robot Control Systems.		
9.	Robot Programming Languages and Systems.	a1, b1, b2	• The Three Levels of Robot Programming • A Sample Application • Requirements of a Robot Programming Language • Problems Peculiar To Robot Programming Languages	1	2
10.	Final Exam.	a1, a2, b1, b2	• All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Tutorial Aspect:

Order	Tutorial	Learning Outcomes	Number of Weeks	Contact Hours
1.	Description of Position and Orientation.	a1, a2	1	2
2.	Robot Forward Kinematics.	a1, a2	2	4
3.	Robot Inverse Kinematics.	a1, a2	2	4
4.	Differential Motions and Velocities.	a1, a2, b1	2	4
5.	Dynamic Analysis and Forces.	a1, a2, b1, b2	2	4
6.	Trajectory Planning.	a1, a2, b2	1	2
7.	Linear Control of Manipulators.	a1, b1, b2	2	4
8.	Non-linear Control of Manipulators.	a1, b1, b2	1	2
9.	Robot Programming Languages and Systems.	a1, b2, c1	1	2
Number of Weeks /and Units Per Semester			**14**	**28**

C - Practical Aspect: (Robotics Lab. & Computer Lab.)				
Order	**Tasks/ Experiments**	**Learning Outcomes**	**Weeks**	**Contact Hours**
1.	**Robotics Toolbox for Matlab:** Introduction to the Tool; Transformations; Robot Kinematics; Differential Motions and Velocities; Dynamics; Trajectory Planning and Control.	b1, b2, c1, c2, d2	1,3,5,7,9	10
2.	**Robot Studio:** Simulations of Different Robot's Performances; Robot Analyzer.	b1, b2, c1, c2, d2	2,4,6,8	8
3.	**Robotics Operation System ROS:** Introduction to ROS; Nodes & Packages; 2D & 3D Models; Localization; Navigation; Mapping; SLAM; ROS Compatible Robots and Hardware.	b1, b2, c1, c2, d2	10,12,13,14	8
4.	**Course Project:** Design and Implementation of a robotic arm for a given task. A report must be prepared and presentation must be delivered. Students work in groups of at least two. Presentation of results are delivered in the last week.	b1, b2, c1, c2, d1, d2	Starts from week 3.	-
5.	Course Project Presentation and Evaluation.	b1, b2, c1, c2, d1, d2	14	2
Number of Weeks /and Units Per Semester			**14**	**28**

V.Teaching strategies of the course:

The teaching strategies of the course are as follows:

- Active Lectures.
- Tutorials.
- Independent Learning.
- Design Work and Project.
- Case Studies.
- The use of Communication and Information Technology.
- Group Learning and Problem-Based Learning.
- Hands-on Laboratory Work.
- Computer-Based Learning.

VI.Assessment Methods of the Course:

The assessment methods of the course are as follows:

- Written Assessments.
- Short Essays.
- Presentations.
- Simulations.
- Practical Assessment.
- Laboratory Reports.
- Project Reports.
- Presentations.

VII.Assignments:

Order	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1.	**Assignment 1:** Robot manipulators kinematics and dynamics**.**	a1, a2, d2	5	5
2.	**Assignment 2:** Robot manipulators control and path planning methods.	a1, a2, d2	10	5
3.	**Assignment 3:** Search the web for solution of a practical problem assigned by the course instructor.	a1, a2, d1, d2	12	5
Total				**15**

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned CILOs
1.	Assignments.	4, 8, 12	15	7.5%	a1, a2, d1, d2
2.	Quizzes.	5, 9, 13	15	7.5%	a1, a2, b1, b2, c1, c2
3.	Mid-Term Exam.	7	20	10%	a1, a2, b1, b2
4.	Lab. Reports.	Weekly	20	10%	b1, b2, c1, c2, d2
5.	Course Project (Hardware Model, Report and Presentation).	15	30	15%	b1, b2, c1, c2, d1, d2

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Quality Assurance Unit
Assoc. Prof. Dr. Mohammad Algorafi

Dean of the Faculty
Prof. Dr. Mohammed AL-Bukhaiti

Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

6.	Final Exam (Theoretical).	16	100	50%	a1, a2, b1, b2
Total			**200**	**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. Craig, J. J., 2005, Introduction To Robotics: Mechanics and Control, 3rd Edition, Singapore, Pearson-Prentice-Hall International Edition.
2. Niku, Saeed B., 2011, Introduction to Robotics: Analysis, Control, Applications, 2nd Edition, USA, WILEY.

2- Essential References.

1. Fu, K.S., Gonzales, R.C., and Lee, C.S.G., 1987, Robotics: Control, Sensing, Vision, and Intelligence, 1st Edition, Singapore, McGraw-Hill Book Company.
2. Corke, Peter I, 2011, Robotics, Vision and Control : Fundamental Algorithms in Matlab. 1st Edition, New York: Springer.
3. Spong M.W., Hutchinson S. & Vidyasagar M., 2004, Robot Dynamics and Control, 2nd Edition, India, Wiley.

3- Electronic Materials and Web Sites *etc*.

Websites:

1. Robot Books http://www.robotbooks.com
2. Center for Educational Resources (CERES) Project http://btc.montana.edu/ceres
3. Robotics research forum for academics and practitioners http://www.roboticscommunity.com/
4. Online robotics links http://chinese-school.netfirms.com/robot-resources.html
5. National Robotics Education Foundation (NREF) http://www.the-nref.org/
6. Robot Research and Information http://www.autopenhosting.org/robots/research.html
7. RoboRealm: A free application for use in machine vision, image analysis, and robotic vision systems http://www.roborealm.com/
8. NASA Robotics https://robotics.nasa.gov/links/resources.php
9. MIT Open Course Ware, Introduction to Robotics https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/

	10. MIT Open Course Ware, Design of Electromechanical Robotic Systems https://ocw.mit.edu/courses/mechanical-engineering/2-017j-design-of-electromechanical-robotic-systems-fall-2009/ **Journals:** 1. IEEE Transactions on Robotics, https://ieeexplore.ieee.org/xpl/aboutJournal.jsp?punumber=8860 2. International Journal of Robotics Research, http://www.ijrr.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 university. behalf according to the policy, rules and regulations of the
7.	**Other policies:** • All the teaching materials should be kept out the examination hall. • The mobile phone is not allowed. • There should be a respect between the student and his teacher.

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. Head of Mechatronics Engineering Department: Assoc. Prof. Dr. Abdul-Malik Momin.

Head of the Department Assoc. Prof. Dr. Abdul-Malik Momin	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad	Rector of Sana'a University Prof. Dr. Al-Qassim Mohammed Abbas

	Deputy Rector for Academic Affairs Assoc. Prof. Dr. Ibrahim AlMutaa. Assoc. Prof. Dr. Ahmed Mujahed. Asst. Prof. Dr. Munaser Alsubari.

Course Plan of Robotics

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Asst. Prof. Dr. Hatem Al-Dois.	**Office Hours**					
Location& Telephone No.	7746 7749 3.	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	haldois@yahoo.com.						

II. Course Identification and General Information:

.1	Course Title:	Robotics.				
.2	Course Code & Number:	MT311.				
.3	Credit Hours:	C.H.				TOTAL Cr. Hrs.
		Th.	Seminar	Pr.	Tu.	
		2	--	2	2	4
.4	Study Level/ Semester at which this Course is Offered:	Fourth Year - Second Semester.				
.5	Pre –requisite (if any):	Design of Machine Elements, Digital Control System, Embedded Systems and Interfacing and Industrial Automation.				
.6	Co –requisite (if any):	None.				
7.	Program (s) in which the Course is Offered:	Mechatronics Engineering Program.				
8.	Language Teaching the Course:	English Language.				
.9	System of Study:	Semesters.				
10.	Mode of Delivery:	Lectures, Tutorials and Labs.				
11.	Location of Teaching the Course:	Mechatronics Engineering Department.				

III. Course Description:

This course provides students with essential knowledge and foundation of robotics. The contents of the course are distributed into six main areas: description of position and orientation; robot's forward and inverse kinematics; robot dynamics, differential motions and Jacobian; trajectory planning; and robot control systems. Tutorial classes are provided to support the foundation concepts given in theoretical classes through a variety of design problems. In practical sessions, students learn different computer tools for robot design and analysis such as: Robotics Toolbox for Matlab, Robot Studio, and RoS. In addition, the course includes a group-based term project in which students will design and fabricate working robotic systems.

IV.	Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1.	Characterize knowledge of robot's different structures, forward and inverse kinematics, dynamics, trajectory planning, and control methods.	A1
a2.	List different robot design configurations for various industrial and non-industrial applications.	A2
b1.	Formulate solutions to common mechatronics problems using robotic systems with suitable hardware and software components.	B1
b2.	Analyze results of different simulation tools for different robot mechanisms, kinematic and dynamic models, motion profiles, and control schemes of robotic manipulators.	B2
c1.	Practice different modeling, simulation and analyses software of robot manipulators performance for various applications.	C2
c2.	Employ suitable hardware and software components for useful robotic manipulator designs in a given task.	C3
d1.	Cooperate effectively in work as a part of a team during the design and implementation of the project and assignment works.	D1
d2.	Review effective technical reports and project presentations during lab sessions and term-project in robotics.	D6

V. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours

1.	Fundamentals.	• Robotics Definitions, Classification, History, Advantages and Disadvantages, DoFs, Components, and Applications. • Robot Reference Frames and Coordinates. • Robot Languages and • Programming Modes.	1,2	4
2.	Robot Kinematics.	• Description of Position and Orientation. • Denavit-Hartenberg Convention of Forward Kinematics. • The Inverse Kinematic Solutions. • Degeneracy and Dexterity. • Computational Considerations.	3,4	4
3.	Differential Motions and Velocities.	• Differential Motions of a Frame. • Differential Relationships of Velocities. • Calculation of the Jacobian. • Jacobian in Different Frames. • Jacobian in the Force Domain/ • Singularity. • Jacobian in the Cartesian Space.	5,6	4
4.	Mid-Term Exam.	• The First 3 Chapters.	7	2
5.	Dynamic Analysis and Forces.	• Newton and Lagrangian Mechanics. • Transformation of Forces and Moments between Coordinate Frames. • Dynamic Equations for Multiple-DoF Robots. • Structure of Robot Dynamics Equation. • Newton-Euler Vs. Lagrange Euler Equations of Robots Motion. • Static Force Analysis of Robots. • Robots Dynamics in Cartesian Space.	8,9	4
6.	Trajectory Planning.	• Basics of Trajectory Planning. Path Vs. Trajectory. • Joint Space Vs. Cartesian-Space Trajectories. • Cubic, Quantic, Trapezoidal, and Linear Segments with Parabolic Blends Trajectories. • Collision-Free Path Planning.	10	2
7.	Linear Control of Manipulators.	• Feedback and Closed-Loop Control. • Control of Second-Order Systems. • Control-Law Partitioning.	11,12	4

		• Trajectory-Following Control. • Disturbance Rejection. • Continuous Vs. Discrete Time Control. • Independent Joint Control System. • Modeling and Control of a Single Joint. • Architecture of an Industrial-Robot Controller.		
8.	Nonlinear Control of Manipulators.	• Nonlinear and Time-Varying Systems. • Multi-Input, Multi-Output Control Systems. • The Control Problem for Manipulators. • Model-Based Control System. • Feed-Forward Control System. • Practical Considerations. • Current Industrial-Robot Control Systems.	13,14	4
9.	Robot Programming Languages and Systems.	• The Three Levels of Robot Programming. • A Sample Application. • Requirements of a Robot Programming Language. • Problems Peculiar To Robot Programming Languages	15	2
10.	Final Exam.	• All the Chapters.	16	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Tutorial Aspect:

Order	Tutorial	Learning Outcomes	Number of Weeks	Contact Hours
1.	Description of Position and Orientation.	a1, a2	1	2
2.	Robot Forward Kinematics.	a1, a2	2,3	4
3.	Robot Inverse Kinematics.	a1, a2	4,5	4
4.	Differential Motions and Velocities.	a1, a2, b1	6,7	4
5.	Dynamic Analysis and Forces.	a1, a2, b1, b2	8,9	4
6.	Trajectory Planning.	a1, a2, b2	10	2

7.	Linear Control of Manipulators.	a1, b1, b2	11,12	4
8.	Non-linear Control of Manipulators.	a1, b1, b2	13	2
9.	Robot Programming Languages and Systems.	a1, b2, c1	14	2
Number of Weeks /and Units Per Semester			**14**	**28**

C - Practical Aspect: (Robotics Lab. & Computer Lab.)

Order	Tasks/ Experiments	Learning Outcomes	Weeks	Contact Hours
1.	**Robotics Toolbox for Matlab:** Introduction to the Tool; Transformations; Robot Kinematics; Differential Motions and Velocities; Dynamics; Trajectory Planning and Control.	b1, b2, c1, c2, d2	1,3,5,7,9	10
2.	**Robot Studio:** Simulations of Different Robot's Performances; Robot Analyzer.	b1, b2, c1, c2, d2	2,4,6,8	8
3.	**Robotics Operation System ROS:** Introduction to ROS; Nodes & Packages; 2D & 3D Models; Localization; Navigation; Mapping; SLAM; ROS Compatible Robots and Hardware.	b1, b2, c1, c2, d2	10,12,13,14	8
4.	**Course Project:** Design and Implementation of a robotic arm for a given task. A report must be prepared and presentation must be delivered. Students work in groups of at least two. Presentation of results are delivered in the last week.	b1, b2, c1, c2, d1, d2	Starts from week 3.	-
5.	Course Project Presentation and Evaluation.	b1, b2, c1, c2, d1, d2	14	2
Number of Weeks /and Units Per Semester			**14**	**28**

VI. Teaching Strategies of the Course:

The teaching strategies of the course are as follows:

- Active Lectures.

- Tutorials.
- Independent Learning.
- Design Work and Project.
- Case Studies.
- The use of Communication and Information Technology.
- Group Learning and Problem-Based Learning.
- Hands-on Laboratory Work.
- Computer-Based Learning.
- Presentations.

VII. Assignments:

Order	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1.	**Assignment 1:** Robot manipulators kinematics and dynamics**.**	a1, a2, d2	5	5
2.	**Assignment 2:** Robot manipulators control and path planning methods.	a1, a2, d2	10	5
3.	**Assignment 3:** Search the web for solution of a practical problem assigned by the course instructor.	a1, a2, d1, d2	12	5
Total				**15**

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned CILOs
1.	Assignments.	4, 8, 12	15	7.5%	a1, a2, d1, d2
2.	Quizzes.	5, 9, 13	15	7.5%	a1, a2, b1, b2, c1, c2
3.	Mid-Term Exam.	7	20	10%	a1, a2, b1, b2
4.	Lab. Reports.	Weekly	20	10%	b1, b2, c1, c2, d2
5.	Course Project (Hardware Model, Report and Presentation).	15	30	15%	b1, b2, c1, c2, d1, d2

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Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

6.	Final Exam (Theoretical).	16	100	50%	a1, a2, b1, b2
Total			**200**	**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).

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2. Niku, Saeed B., 2011, Introduction to Robotics: Analysis, Control, Applications, 2nd Edition, USA, WILEY.

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2. Corke, Peter I, 2011, Robotics, Vision and Control : Fundamental Algorithms in Matlab. 1st Edition, New York: Springer.
3. Spong M.W., Hutchinson S. & Vidyasagar M., 2004, Robot Dynamics and Control, 2nd Edition, India, Wiley.

3- Electronic Materials and Web Sites *etc*.

Websites:

1. Robot Books
   http://www.robotbooks.com
2. Center for Educational Resources (CERES) Project
   http://btc.montana.edu/ceres
3. Robotics research forum for academics and practitioners
   http://www.roboticscommunity.com/
4. Online robotics links
   http://chinese-school.netfirms.com/robot-resources.html
5. National Robotics Education Foundation (NREF)
   http://www.the-nref.org/
6. Robot Research and Information
   http://www.autopenhosting.org/robots/research.html
7. RoboRealm: A free application for use in machine vision, image analysis, and robotic vision systems
   http://www.roborealm.com/
8. NASA Robotics
9. https://robotics.nasa.gov/links/resources.php
10. MIT Open Course Ware, Introduction to Robotics
11. https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/

	12. MIT Open Course Ware, Design of Electromechanical Robotic Systems 13. https://ocw.mit.edu/courses/mechanical-engineering/2-017j-design-of-electromechanical-robotic-systems-fall-2009/ **Journals:** 1. IEEE Transactions on Robotics, 2. https://ieeexplore.ieee.org/xpl/aboutJournal.jsp?punumber=8860 3. International Journal of Robotics Research, 4. http://www.ijrr.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 students attend the exam on another university. behalf according to the policy, rules and regulations of the
7.	**Other Policies:** • All the teaching materials should be kept out the examination hall. • The mobile phone is not allowed. • There should be a respect between the student and his teacher.