14- Course Specification of Automation in Manufacturing Systems Course Code (ME517)

• General Information About the Course:

1.	**Course Title:**	Automation in Manufacturing Systems			
2.	**Course Code and Number:**	ME517			
3.	**Credit Hours:**	**Credit Hours**			**Total**
		Lecture	Practical	Seminar/Tutorial	
		3	--	--	**3**
4.	**Study Level and Semester:**	1st Level / 2nd Semester (Elective)			
5.	**Pre-requisites (if any):**	ME233			
6.	**Co-requisites (if any):**	ME516			
7.	**Program (s) in which the course is offered:**	MSc. In Mechanical Engineering Program			
8.	**Language of teaching the course:**	English			
9.	**Study System:**	Courses & Thesis			
10.	**Prepared By:**	Dr. Khalil Al-Hatab			
11.	**Reviewed by:**	Dr. ……			
12.	**Date of Approval:**				

• Course Description:

This course intends to provide the in-depth knowledge of essential automation processes, methods, technologies, components and scenarios for control energy; material; and information flows in the modern manufacturing systems. The course covers: CNC centres, robotics, PLC, automation materials handling systems, single station automated cells, automated assembly lines, GT and FMS. Graduates will perform a term-project tasks in groups and offer a step-by-step design process on an automated system taken from different manufacturing domains. Which enables them to get a hands-on experience; develop problem solving and collaboration skills and achieve outstanding results and display their career-readiness in a valid, measurable format.

• Course Intended Learning Outcomes (CILOs):

Upon successful completion of **Automation in Manufacturing Systems Course**, the graduates will be able to:

a1. Define and list basic elements and components of automation and describe its concepts, strategies, levels, and applications in manufacturing contexts.

a2. Explain advantages and disadvantages and various reasons for employing automation and evaluate contemporary automation technologies, developments and emerging trends in a manufacturing environment.

a3. Describe the fundamentals, basic anatomy, attributes and function of an automated system as whole (CNC, robotics...) or as its components (sensors, actuators and other control system components) and give examples of both categories.

b1. Recognize characteristics, constructional and operational details, interfaces and current developments and technologies relevant to automation in manufacturing systems.

b2. Practice and create quantitative analysis and innovative solutions for a complex automation problem in manufacturing within realistic constrains.

b3. Design automated systems and assess their operational errors and recovery procedures within realistic constrains, standards and practices to meet defined operational specifications.

c1. Select and integrate an appropriate sensor, actuators and other control system components and develop computer-programs and codes while constructing a useful automated system.

c2. Research and summarize a unique technology and/or application in the design of an automated system to meet defined operational specifications.

d1. Communicate effectively ideas, work procedures, analysis and results of the project/case studies in both written and orally forms with a range of audiences.

d2. Undertake lifelong learning of the developments in the field of industrial automated system.

d3. Support a team effort through effectively manage tasks; time; processes; resources to study, design and analysis of an industrial automated system.

• Alignment of Course Intended Learning Outcomes (CILOs) to Program Intended Learning Outcomes (PILOs)

CILOs		PILOs
• **Knowledge and Understanding:** Upon successful completion of **Automation in Manufacturing Systems Course,** the graduates will be able to:		• **Knowledge and Understanding:** Upon successful completion of the **MSc. In Mechanical Engineering Program**, the graduates will be able to:
a1.	Define and list basic elements and components of automation and describe its concepts, strategies, levels, and applications in manufacturing contexts.	**A1.** Acquire advanced concepts and knowledge of mathematics, scientific, mechanical engineering and associated technologies as well as across the boundaries of interdisciplinary disciplines.
a2.	Explain advantages and disadvantages and various reasons for employing automation and evaluate contemporary automation technologies, developments and emerging trends in a manufacturing environment.	**A2.** Identify and critically evaluate contemporary engineering technologies, current developments and emerging trends within the mechanical engineering contexts.

a3.	Describe the fundamentals, basic anatomy and attributes and basic function of an automated system as whole (CNC, robotics...) or as its components (sensors, actuators and other control system components) and give examples of both categories.	**A3.** Provide a holistic description of principles, concepts, approaches, techniques and analysis tools to design and development of existing and novel mechanical systems, while taking a sustainable and environmentally-friendly approach.
• **Cognitive/ Intellectual Skills:** Upon successful completion of the **Automation in Manufacturing Systems Course,** the graduates will be able to:		• **Cognitive/ Intellectual Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:
b1.	Recognize characteristics, constructional and operational details, interfaces and current developments and technologies relevant to automation in manufacturing systems.	**B1.** Identify and apply specialized knowledge and skills to solve problems that are critical to future growth of industry and business.
b2.	Practice and create quantitative analysis and innovative solutions for a complex automation problem in manufacturing within realistic constrains.	**B2.** Creatively thinking and apply analysis tools to formulate and solve complex engineering problems in the mechanical engineering context using modern techniques and tools.
b3.	Design automated systems and assess their operational errors and recovery procedures within realistic constrains, standards and practices to meet defined operational specifications.	**B3.** Design and optimize mechanical components, systems and process to meet desired needs within realistic constraints.
b4.		**B4.** Analyze and assess risks of the professional practice in the mechanical engineering contexts.
• **Professional and Practical Skills:** Upon successful completion of the **Automation in Manufacturing Systems Course,** the graduates will be able to:		• **Professional and Practical Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:
c1.	Select and integrate an appropriate sensor, actuators and other control system components and develop computer-programs and codes while constructing a useful automated system.	**C1.** Use modern manufacturing processes and materials, experimental tests, appropriate software packages and other modern tools for the design analysis and manufacture of mechanical components and systems.
c2.	Research and summarize a unique technology and/or application in the design of an automated system to meet defined operational specifications.	**C2.** Conduct research and studies to solve mechanical engineering problems professionally, ethically and responsibly within realistic constraints.
c3.		**C3.** Demonstrate an in-depth understanding of the mechanical engineering business environment, including environmental aspects, and apply quality issues, modern operations and business management

		techniques and good practices in a range of contexts.
c4.		
• **Transferable Skills:** Upon successful completion of the **Automation in Manufacturing Systems Course,** the graduates will be able to:		• **Transferable Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:
		D1. Adopt effectively IT capabilities and other different resources of information to develop a scientific research in mechanical engineering fields.
d1.	Communicate effectively ideas, work procedures, analysis and results of the project/case studies in both written and orally forms with a range of audiences.	**D2.** Communicate, present, challenge and defend research ideas, results and conclusions in both orally and writing forms to different audiences in contexts.
d2.	Undertake lifelong learning of the developments in the field of industrial automated system.	**D3.** Identify a need for the latest relevant knowledge and technologies and undertake life-long learning.
d3.	Support a team effort through effectively manage tasks; time; processes; resources to study, design and analysis of an industrial automated system.	**D4.** Collaborate effectively within multidisciplinary teams and lead them in different professional contexts

• Alignment of CILOs to Teaching and Assessment Strategies

• Alignment of Knowledge and Understanding CILOs:

	Knowledge and Understanding CILOs	Teaching Strategies	Assessment Strategies
a1.	Define and list basic elements and components of automation and describe its concepts, strategies, levels, and applications in manufacturing contexts.	▪ Lectures, ▪ Students' Presentations ▪ Class Discussion ▪ Self-Learning ▪ Problems/Studies, ▪ Case Study, ▪ Individual/Group Projects	▪ Quizzes & Writing Exams ▪ Projects Reports, ▪ Homework Assignments.
a2.	Explain advantages and disadvantages and various reasons for employing automation and evaluate contemporary automation technologies, developments and emerging trends in a manufacturing environment.	▪ Lectures, ▪ Students' Presentations ▪ Class Discussion ▪ Self-Learning ▪ Problems/Studies, ▪ Case Study, ▪ Individual/Group Projects ▪ Active Learning,	▪ Quizzes & Writing Exams ▪ Projects Reports, ▪ Homework Assignments.
a3.	Describe the fundamentals, basic anatomy and attributes and basic function	▪ Lectures, ▪ Students'	▪ Quizzes & Writing Exams

	of an automated system as whole (CNC, robotics...) or as its components (sensors, actuators and other control system components) and give examples of both categories.	Presentations ▪ Class Discussion ▪ Self-Learning ▪ Problems/Studies, ▪ Case Study, ▪ Individual/Group Projects ▪ Active Learning,	▪ Projects Reports, ▪ Homework Assignments.

- **Alignment of Intellectual Skills CILOs:**

Intellectual Skills CILOs		Teaching Strategies	Assessment Strategies
b1.	Recognize characteristics, constructional and operational details, interfaces and current developments and technologies relevant to automation in manufacturing systems.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning, ▪ Simulation Software Application.	▪ Quizzes & Writing Exams ▪ Projects Reports, ▪ Homework Assignments ▪ Students' Seminars and Presentations. ▪ Case Study Reports.
b2.	Practice and create quantitative analysis and innovative solutions for a complex automation problem in manufacturing within realistic constrains.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning, ▪ Simulation Software Application.	▪ Quizzes & Writing Exams ▪ Projects Reports, ▪ Homework Assignments ▪ Students' Seminars and Presentations. ▪ Case Study Reports.
b3.	Design automated systems and assess their operational errors and recovery procedures within realistic constrains, standards and practices to meet defined operational specifications.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case Study, ▪ Individual/Group Projects and Studies, ▪ Active Learning, ▪ Simulation Software Application.	▪ Quizzes & Writing Exams ▪ Projects Reports, ▪ Homework Assignments ▪ Students' Seminars and Presentations. ▪ Case Study Reports.

- **Alignment of Professional and Practical Skills CILOs:**

Professional and Practical Skills CILOs		Teaching Strategies	Assessment Strategies
c1.	Select and integrate an appropriate sensor, actuators and other control system components and develop computer-programs and codes while constructing a useful automated system.	▪ Individual/Group Projects and Studies, ▪ Active Learning, ▪ Case Study Analysis	▪ Quizzes & Writing Exams ▪ Projects Reports, ▪ Homework Assignments ▪ Specific Assignments. ▪ Written reports. ▪ Students' Seminars and Presentations.

c2.	Research and summarize a unique technology and/or application in the design of an automated system to meet defined operational specifications.	▪ Self-Learning ▪ Problems/Studies, ▪ Individual/Group Projects and Studies, ▪ Active Learning, ▪ Computer Hands-on Sessions. ▪ Case Study Analysis	▪ Projects Reports, ▪ Specific Assignments. ▪ Written Reports. ▪ Students' Seminars and Presentations.
• **Alignment of Transferable (General) Skills CILOs:**			
Transferable (General) Skills CILOs		**Teaching Strategies**	**Assessment Strategies**
d1.	Communicate effectively ideas, work procedures, analysis and results of the project/case studies in both written and orally forms with a range of audiences.	▪ Independent Study, ▪ Individual/Group Projects and Studies, ▪ Presentation,	▪ Presentation, ▪ Written Report
d2.	Undertake lifelong learning of the developments in the field of industrial automated system.	▪ Independent Study, ▪ Individual/Group Projects and Studies,	▪ Presentation, ▪ Written Report.
d3.	Support a team effort through effectively manage tasks; time; processes; resources to study, design and analysis of an industrial automated system.	▪ Individual/Group Projects and Studies,	▪ Presentation, ▪ Written Report.

• Course Content

• Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course ILOs
1	**Chapter 1: Introduction to Automation**	– Course Introduction – Definition of Automation – Advantages & Disadvantages of Automation – Automation in Production Systems – Identify Types of Automation – Reasons for Automating – Automation Principles & Strategies	**2**	**6**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
		– Basic Concept of Automation Terminology (i.e.; Link, Joint, DOF, Orientation Axes, Position Axes, TCP, etc.) – Positioning Concept of Automation **(**Accuracy and Repeatability, Control Resolution and Payload). – Challenges of Process Automation – Basic Component of an Automation System – Function of an Automation Systems ▪ Safety Monitoring ▪ Maintenance & Repair Diagnostics ▪ Error Detection & Recovery – Levels of Automation			
2	**Chapter 2: Overview of Manufacturing Operations & Systems**	– Manufacturing Industries and Products – Manufacturing Operations – Production Facilities – Product/Production Relationships – Production Performance Metrics – Manufacturing Costs – Overview of Manufacturing Systems ▪ Components of a Manufacturing System ▪ Types of Manufacturing Systems	**1**	**3**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
3	**Chapter 3: Design of Industrial Automation Systems**	– Automation System in an Application – Automation Design and process specifications 1. System Specifications 2. Mechanical Description of the Automation 3. Motion Sequence 4. Motor and Drive Mechanism Selection – Encoder Selection – Control Structure	**1**	**3**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**

4	**Chapter 4: Mechanical System: Components, Dynamics & Modeling**	– Elementary Mechanical Concepts 1. Translation or Linear Motion 2. Rotational Motion 3. Mechanical Work and power – Motion Conversion ▪ Rotary to Rotary Motion Conversion ▪ Rotary to Linear Motion Conversion ▪ Linkages ▪ Couplers ▪ The Concept of Power Transfer – Modeling of Mechanical System 1. Elements, Rules and Nomenclature 2. Translational Example 3. Rotational Example 4. Electrical Analog – End Effectors ▪ The Grapping Problem ▪ Remote Centered Compliance Devices	**1**	**3**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
5	**Chapter 5: Automation Sensors & Actuators**	– Sensor Characteristics – Sensor Classification – Angular and Linear Position Sensors – Velocity and Acceleration Sensors – Contact Sensor – Distance and Velocity Sensor – Electrical Motors Actuators – Solenoid Actuators – Hydraulic Actuators – Pneumatic Actuators – Apply Control Method of Actuators – Relays – Analog/Digital Conversions – I/O Devices for Discrete Data	**2**	**6**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
6	**Chapter 6: Industrial Control Systems**	– Mid-Term Exam (Theoretical) – Process Industries Versus Discrete Manufacturing Industries – Continuous Control ▪ Regulatory Control ▪ Feedforward Control ▪ Steady-State Optimization ▪ Adaptive Control ▪ On-Line Search Strategies ▪ Other Specialized Techniques	**2**	**6**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**

		– Computer Process Control – Forms of Computer Process Control ▪ Computer Process Monitoring ▪ Direct Digital Control ▪ Distributed Control System ▪ Programmable Logic Controllers ▪ Supervisory Control and Data Acquisition ▪ PCs in Process Control – Discrete Process Control ▪ Logic Control ▪ Sequence Control			
7	**Chapter 7: Computer Numerical Control**	– Fundamentals of NC Technology – Computers and Numerical Control – Applications of NC – Analysis of Positioning Systems – NC Part Programming	**1**	**3**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
8	**Chapter 8: Industrial Robotics & Programmable Logic Controllers (PLCs)**	– Industrial Robotics ▪ Robot Anatomy and Related Attributes ▪ Robot Control Systems ▪ Applications of Industrial Robots ▪ Robot Programming – Programmable Logic Controllers (PLCs) ▪ Ladder Logic Diagrams ▪ Programmable Logic Controllers ▪ Personal Computers and Programmable Automation Controllers	**1**	**3**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
9	**Chapter 9: Material Handling & Identification Systems**	– Overview of Material Handling – Material Transport Equipment – Analysis of Material Transport Systems – Storage Systems – Conventional Storage Methods and Equipment – Automated Storage Systems – Analysis of Storage Systems – Overview of Automatic Identification Method – Radio Frequency Identification – Other AIDC Technologies	**1**	**3**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**

10	**Chapter 10: Manufacturing Systems**	– Single-Station Manufacturing Cells ▪ Single-Station Manned Cells ▪ Single-Station Automated Cell ▪ Applications of Single-Station Cells ▪ Analysis of Single-Station Cells – Manual Assembly Lines ▪ Fundamentals of Manual Assembly Lines ▪ Analysis of Single-Model Assembly Lines ▪ Line Balancing Algorithms ▪ Workstation Details	**3**	**9**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
		– Automated Production Lines ▪ Fundamentals of Automated Production Lines ▪ Applications of Automated Production Lines ▪ Analysis of Transfer Lines – Automated Assembly Systems ▪ Fundamentals of Automated Assembly Systems ▪ Analysis of Automated Assembly Systems			
		– Group Technology & Cellular Manufacturing ▪ Part Families and Machine Groups ▪ Cellular Manufacturing ▪ Applications of Group Technology ▪ Analysis of Cellular Manufacturing – Flexible Manufacturing Cells & Systems ▪ Manufacturing Flexibility Defined ▪ FMC/FMS Components ▪ FMS Application Considerations ▪ Analysis of Flexible Manufacturing Systems ▪ Alternative Approaches to Flexible Manufacturing ▪ Manufacturing Support Systems			

11	Final Exam (Theoretical)	All Previous Topics	1	3	a1, a2, a3, b1, b2, b3, c1, c2, d1
Number of Weeks /and Contact Hours Per Semester			16	48	

- **Practical Aspect**

Order	Practical / Tutorials topics	Number of Weeks	Contact Hours	Course ILOs
1	▪ None			
Number of Weeks /and Contact Hours Per Semester				

- **Tutorial Aspect:**

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	• None			
Number of Weeks /and Units Per Semester				

• Teaching Strategies:

- Lectures,
- Self-Learning Problems/Studies,
- Case study,
- Individual Projects and Studies,
- Active learning,
- Computer hands-on sessions.
- Independent Study, and
- Presentation

• Assessment Methods of the Course:

- Oral & Writing Exams
- Individual/Group Projects and Studies Reports,
- Presentation,
- Assignments

• Tasks and Assignments:

No	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)
1	**Homework Assignments (10 sets)**	**Individual**	**10**	**Weekly**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
2	**Group Design Projects:** Objective: Students will learn how to design an integrated manufacturing system by selecting and building a complete integrated system from beginning to end. Method: The basic steps are outlined below, 1. Course begins 2. Students groups will submit a proposal for a project within the first three weeks. 3. The instructor will review the proposal, and suggest changes as necessary. 4. During the term students will design, build and test their proposed projects. 5. In the last week of classes the final project will be demonstrated and formally presented. **Group Design Projects** (1 total)**:** Students groups are required to design an example for industrial automation system. Design should include: **a.** Physical systems modeling (drawing, mechanism and so on) **b.** Sensors and actuators **c.** Logic control system (PLC) Choose any of those projects: **1.** Adhesive Dispensing Cells **2.** Assembly Assist Stations **3.** Automated Riveters **4.** Automatic Drilling / Tapping **5.** Automatic Packaging **6.** Automatic/Semi-Automatic and Manual Screw Driving Systems **7.** Automatic Staplers Bar Code Reading **8.** Rotary Assembly Systems **9.** Special Machines and Fixtures Tube Benders **10.** Ultrasonic Welding Equipment	**Group**	**20**	**W3, W7, W11 & W15**	**a1, a2, a3, b1, b2, b3, c1, c2, d1, d2, d3**

	11. Vision Inspection and Vision Guided Systems. **12.** Automatic Drilling Machine **13.** Automobile Hood Latch **14.** Hydraulic Lift **15.** Car Jack **16.** Transfer Device				
	Total Score		**30**	==	===

• Learning Assessment:

No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment	CILOs
1	**Tasks and Assignments**	**Weekly**	**30**	**20%**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
2	**Quizzes**	**W5, W10 & W13**	**10**	**6.7%**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
3	**Midterm Exam (Theoretical)**	**W8**	**30**	**20%**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
4	**Final Exam (Theoretical)**	**W16**	**80**	**53.3%**	**a1, a2, a3, b1, b2, b3, c1, c2, d1**
Total			**150**	**100%**	**===**

• Learning Resources :

1 Required Textbook(s) :

1. Groover, M. P.,2015, **Automation, Production Systems, and Computer-Integrated Manufacturing**, 4th Edition, USA, Pearson Education.

2 Essential References:

Frank L., 2013, **Industrial Automation-Hands-On**, New York, McGraw-Hill Education

Chanchal D., Sunit K. S., 2020, **Industrial Automation Technologies,** First Edition, Boca Raton and London, Taylor & Francis Group, LLC.

Daniel E. Kandray, P.E., 2010, **Programmable Automation Technologies an Introduction to CNC, Robotics and PLCs**, 1st Edition, New York, Industrial Press Inc.

Terry B., 2011, **Industrial Automated Systems Instrumentation and Motion Control**, 1st Edition, USA, Delmar, Cengage Learning.

Thomas Boucher, 2002, **Computer Control of Manufacturing systems**, Springer Ver-lag.

Richard C. Dorf and Andrew Kusiak, 1994, **Handbook of design, manufacturing and automation**, John Wiley & Sons, Inc.

Shimon Y. Nof editor, 2009, **Springer Handbook of Automation**, Springer-Verlag Berlin

Heidelberg.

3 Electronic Materials and Web Sites etc.

Websites:

1- **Journals**:

1. International Journal of Automation and Computing
2. Journal of Automation and Information Sciences.
3. Journal of Design and Manufacturing Automation

2- **Software/Learning Websites**

(1) PLC simulator

(2) DCS simulator

3- **Learning Websites**

i. www.control.com
ii. www.plcs.net
iii. www.pacontrol.com
iv. En.wikipedia.org
v. www.seimens.com
vi. www. ab.rockwellautomation.com › Allen-Bradley
vii. www.abb.co.in
viii. . www.triplc.com
ix. http://plc-training-rslogix-simulator.soft32.com/free-download/
x. www.youtube.com
xi. www.ourinstrumentationgroup.com
xii. www.plcsimulator.net/
xiii. http://scada.winsite.com

• الضوابط والسياسات المتبعة في المقرر Course Policies	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
سياسة حضور الفعاليات التعليمية Class Attendance: - يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك. - يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم.	1
الحضور المتأخر Tardy: - يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة.	2
ضوابط الامتحان Exam Attendance/Punctuality: - لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان - إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية.	3
التعيينات والمشاريع Assignments & Projects: - يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها. - إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه.	4
الغش Cheating:	5

	- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب. - في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.
6	**الانتحال Plagiarism:** - في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك
7	**سياسات أخرى Other policies:** - أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ

Academic Year: ……....

Course Plan (Syllabus) Automation in Manufacturing Systems Course Code (ME517)

• Information about Faculty Member Responsible for the Course:

Name		**Office Hours**						
Location &Telephone No.		**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail							

• General information about the course:

	Course Title	Automation in Manufacturing Systems			
2.	**Course Code and Number**	ME517			
3.	**Credit Hours**	**Credit Hours**			**Total**
		Lecture	**Practical**	**Seminar/Tutorial**	
		3	--	--	**3**
4.	**Study Level and Semester**	1st Level / 2nd Semester (Elective)			
5.	**Pre-requisites**	ME233			
6.	**Co –requisite**	ME516			
7.	**Program (s) in which the course is offered**	MSc. In Mechanical Engineering Program			
8.	**Language of teaching the course**	English			
9.	**Location of teaching the course**	Faculty Buildings			

• Course Description:

This course intends to provide the in-depth knowledge of essential automation processes, methods, technologies, components and scenarios for control energy; material; and information flows in the modern manufacturing systems. The course covers: CNC centres, robotics, PLC, automation materials handling systems, single station automated cells, automated assembly lines, GT and FMS. Graduates will perform a term-project tasks in groups and offer a step-by-step design process on an automated system taken from different manufacturing domains. Which enables them to get a hands-on experience; develop problem solving and collaboration skills and achieve outstanding results and display their career-readiness in a valid, measurable format.

• Course Intended Learning Outcomes (CILOs):

Upon successful completion of **Automation in Manufacturing Systems Course**, the graduates will be able to:

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a3. Describe the fundamentals, basic anatomy, attributes and function of an automated system as whole (CNC, robotics...) or as its components (sensors, actuators and other control system components) and give examples of both categories.

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b3. Design automated systems and assess their operational errors and recovery procedures within realistic constrains, standards and practices to meet defined operational specifications.

c1. Select and integrate an appropriate sensor, actuators and other control system components and develop computer-programs and codes while constructing a useful automated system.

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d2. Undertake lifelong learning of the developments in the field of industrial automated system.

d3. Support a team effort through effectively manage tasks; time; processes; resources to study, design and analysis of an industrial automated system.

- **Course Content:**
  - **Theoretical Aspect:**

Order	Units	Sub Topics	Week Due	Contact Hours
1	**Chapter 1: Introduction to Automation**	– Course Introduction – Definition of Automation – Advantages & Disadvantages of Automation – Automation in Production Systems – Identify Types of Automation – Reasons for Automating – Automation Principles & Strategies	**W1**	**3**
		– Basic Concept of Automation Terminology (i.e.; Link, Joint, DOF, Orientation Axes, Position Axes, TCP, etc.) – Positioning Concept of Automation (Accuracy and Repeatability, Control Resolution and Payload). – Challenges of Process Automation – Basic Component of an Automation System – Function of an Automation Systems ▪ Safety Monitoring ▪ Maintenance & Repair Diagnostics ▪ Error Detection & Recovery – Levels of Automation	**W2**	**3**
2	**Chapter 2: Overview of Manufacturing Operations & Systems**	– Manufacturing Industries and Products – Manufacturing Operations – Production Facilities – Product/Production Relationships – Production Performance Metrics – Manufacturing Costs – Overview of Manufacturing Systems – Components of a Manufacturing System – Types of Manufacturing Systems	**W3**	**3**
3	**Chapter 3: Design of Industrial Automation Systems**	– Automation System in an Application – Automation Design and process specifications ▪ System Specifications ▪ Mechanical Description of the Automation ▪ Motion Sequence ▪ Motor and Drive Mechanism Selection – Encoder Selection – Control Structure	**W4**	**3**
4	**Chapter 4: Mechanical System: Components, Dynamics & Modeling**	– Elementary Mechanical Concepts 1. Translation or Linear Motion 2. Rotational Motion 3. Mechanical Work and power – Motion Conversion ▪ Rotary to Rotary Motion Conversion	**W5**	**3**

- **Course Content:**
  - **Theoretical Aspect:**

Order	Units	Sub Topics	Week Due	Contact Hours
		▪ Rotary to Linear Motion Conversion ▪ Linkages ▪ Couplers ▪ The Concept of Power Transfer – Modeling of Mechanical System 1. Elements, Rules and Nomenclature 2. Translational Example 3. Rotational Example 4. Electrical Analog – End Effectors ▪ The Grapping Problem ▪ Remote Centered Compliance Devices		
5	**Chapter 5: Automation Sensors & Actuators**	– Sensor Characteristics – Sensor Classification – Angular and Linear Position Sensors – Velocity and Acceleration Sensors – Contact Sensor – Distance and Velocity Sensor	**W6**	**3**
		– Electrical Motors Actuators – Solenoid Actuators – Hydraulic Actuators – Pneumatic Actuators – Apply Control Method of Actuators – Relays – Analog/Digital Conversions – I/O Devices for Discrete Data	**W7**	**3**
6	**Chapter 6: Industrial Control Systems**	– Mid-Term Exam (Theoretical) – Process Industries Versus Discrete Manufacturing Industries – Continuous Control ▪ Regulatory Control ▪ Feedforward Control ▪ Steady-State Optimization ▪ Adaptive Control ▪ On-Line Search Strategies ▪ Other Specialized Techniques	**W8**	**3**
		– Computer Process Control – Forms of Computer Process Control ▪ Computer Process Monitoring ▪ Direct Digital Control ▪ Distributed Control System ▪ Programmable Logic Controllers ▪ Supervisory Control and Data Acquisition ▪ PCs in Process Control – Discrete Process Control ▪ Logic Control ▪ Sequence Control	**W9**	**3**

- **Course Content:**
  - **Theoretical Aspect:**

Order	Units	Sub Topics	Week Due	Contact Hours
7	**Chapter 7: Computer Numerical Control**	– Fundamentals of NC Technology – Computers and Numerical Control – Applications of NC – Analysis of Positioning Systems – NC Part Programming	**W10**	**3**
8	**Chapter 8: Industrial Robotics & Programmable Logic Controllers (PLCs)**	– Industrial Robotics ▪ Robot Anatomy and Related Attributes ▪ Robot Control Systems ▪ Applications of Industrial Robots ▪ Robot Programming – Programmable Logic Controllers (PLCs) ▪ Ladder Logic Diagrams ▪ Programmable Logic Controllers ▪ Personal Computers and Programmable Automation Controllers	**W11**	**3**
9	**Chapter 9: Material Handling & Identification Systems**	– Overview of Material Handling – Material Transport Equipment – Analysis of Material Transport Systems – Storage Systems – Conventional Storage Methods and Equipment – Automated Storage Systems – Analysis of Storage Systems – Overview of Automatic Identification Method – Radio Frequency Identification – Other AIDC Technologies	**W12**	**3**
10	**Chapter 10: Manufacturing Systems**	– Single-Station Manufacturing Cells ▪ Single-Station Manned Cells ▪ Single-Station Automated Cell ▪ Applications of Single-Station Cells ▪ Analysis of Single-Station Cells – Manual Assembly Lines ▪ Fundamentals of Manual Assembly Lines ▪ Analysis of Single-Model Assembly Lines ▪ Line Balancing Algorithms ▪ Workstation Details	**W13**	**3**
		– Automated Production Lines	**W14**	**3**

• Course Content:

• Theoretical Aspect:

Order	Units	Sub Topics	Week Due	Contact Hours
		▪ Fundamentals of Automated Production Lines ▪ Applications of Automated Production Lines ▪ Analysis of Transfer Lines – Automated Assembly Systems ▪ Fundamentals of Automated Assembly Systems ▪ Analysis of Automated Assembly Systems		
		– Group Technology & Cellular Manufacturing ▪ Part Families and Machine Groups ▪ Cellular Manufacturing ▪ Applications of Group Technology ▪ Analysis of Cellular Manufacturing – Flexible Manufacturing Cells & Systems ▪ Manufacturing Flexibility Defined ▪ FMC/FMS Components ▪ FMS Application Considerations ▪ Analysis of Flexible Manufacturing Systems ▪ Alternative Approaches to Flexible Manufacturing ▪ Manufacturing Support Systems	**W15**	**3**
11	**Final Exam (Theoretical)**	**All Previous Topics**	**W16**	**3**
Number of Weeks /and Contact Hours Per Semester			**16**	**48**

• Practical Aspect

Order	Practical / Tutorials topics	Number of Weeks	Contact Hours	Course ILOs
1	▪ **None**			
Number of Weeks /and Contact Hours Per Semester				

• Training/ Tutorials/ Exercises Aspects:

Order	Tutorials/ Exercises	Week Due	Contact Hours

1	▪ **None**		
Number of Weeks /and Contact Hours Per Semester			

• Teaching Strategies:

- Lectures,
- Students' Presentations
- Class Discussion
- Self-Learning
- Problems/Studies,
- Case Study,
- Individual/Group Projects
- Active Learning,
- Independent Study
- Simulation Software Application.

• Assessment Methods of the Course:

- Quizzes & Writing Exams
- Projects Reports,
- Homework Assignments
- Students' Seminars and Presentations.
- Case Study Reports.
- Presentation,
- Written Report

• Tasks and Assignments:

No	Assignments	Individual /Groups	Mark	Week Due
1	**Homework Assignments (10 sets)**	**Individual**	**10**	**Weekly**
2	**Group Design Projects:** **Objective:** Students will learn how to design an integrated manufacturing system by selecting and building a complete integrated system from beginning to end. Method: The basic steps are outlined below, 1. Course begins 2. Students groups will submit a proposal for a project within the first three weeks. 3. The instructor will review the proposal, and suggest changes as necessary. 4. During the term students will design, build and test their proposed projects. 5. In the last week of classes the final project will be demonstrated and formally presented. **Group Design Projects** (1 total)**:** Students groups are required to design an example for industrial automation system. Design should include: **a.** Physical systems modeling (drawing, mechanism and so on) **b.** Sensors and actuators **c.** Logic control system (PLC) Choose any of those projects: **1.** Adhesive Dispensing Cells **2.** Assembly Assist Stations **3.** Automated Riveters **4.** Automatic Drilling / Tapping **5.** Automatic Packaging **6.** Automatic/Semi-Automatic and Manual Screw Driving Systems **7.** Automatic Staplers Bar Code Reading	**Group**	**20**	**W3, W7, W11 & W15**

• Tasks and Assignments:

No	Assignments	Individual /Groups	Mark	Week Due
	8. Rotary Assembly Systems **9.** Special Machines and Fixtures Tube Benders **10.** Ultrasonic Welding Equipment **11.** Vision Inspection and Vision Guided Systems. **12.** Automatic Drilling Machine **13.** Automobile Hood Latch **14.** Hydraulic Lift **15.** Car Jack **16.** Transfer Device			
	Total Score		**30**	

• Learning Assessment:

No	Assessment Method	Week Due	Mark	Proportion of Final Assessment %
1	**Tasks and Assignments**	**Weekly**	**30**	**20%**
2	**Quizzes**	**W5, W10 & W13**	**10**	**6.7%**
3	**Midterm Exam (Theoretical)**	**W8**	**30**	**20%**
4	**Final Exam (Theoretical)**	**W16**	**80**	**53.3%**
	Total		**150**	**100%**

• Learning Resources:

1. **Required Textbook(s) :**

1. Groover, M. P.,2016, **Automation, Production Systems, and Computer-Integrated Manufacturing**, 4th Edition, USA, Pearson Education.

2. **Essential References:**

1- Frank L., 2013, **Industrial Automation-Hands-On**, New York, McGraw-Hill Education

Chanchal D., Sunit K. S., 2020, **Industrial Automation Technologies,** First Edition, Boca Raton and London, Taylor & Francis Group, LLC.

Daniel E. Kandray, P.E., 2010, **Programmable Automation Technologies an Introduction to CNC, Robotics and PLCs**, 1st Edition, New York, Industrial Press Inc.

Terry B., 2011, **Industrial Automated Systems Instrumentation and Motion Control**, 1st Edition, USA, Delmar, Cengage Learning.

Thomas Boucher, 2002, **Computer Control of Manufacturing systems**, Springer Ver-lag.

Richard C. Dorf and Andrew Kusiak, 1994, **Handbook of design, manufacturing and automation**, John Wiley & Sons, Inc.

1. Shimon Y. Nof editor, 2009, **Springer Handbook of Automation**, Springer-Verlag Berlin Heidelberg.

3. **Electronic Materials and Web Sites etc.**

Websites:

1- Journals:

1. International Journal of Automation and Computing
2. Journal of Automation and Information Sciences.
3. Journal of Design and Manufacturing Automation

2- Software/Learning Websites

(3) PLC simulator

(4) DCS simulator

3- Learning Websites

i. www.control.com
ii. www.plcs.net
iii. www.pacontrol.com
iv. En.wikipedia.org
v. www.seimens.com
vi. www. ab.rockwellautomation.com › Allen-Bradley
vii. www.abb.co.in
viii. . www.triplc.com
ix. http://plc-training-rslogix-simulator.soft32.com/free-download/
x. www.youtube.com
xi. www.ourinstrumentationgroup.com
xii. www.plcsimulator.net/
xiii. http://scada.winsite.co

• الضوابط والسياسات المتبعة في المقرر Course Policies	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
سياسة حضور الفعاليات التعليمية Class Attendance: - يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك. - يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم.	1
الحضور المتأخر Tardy: - يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة.	2
ضوابط الامتحان Exam Attendance/Punctuality: - لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان - إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية.	3
التعيينات والمشاريع Assignments & Projects: - يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها. - إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه.	4
الغش Cheating: - في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب. - في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.	5
الانتحال Plagiarism:	6

	- في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك
7	**سياسات أخرى Other policies:** - أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ