1- Course Specification of: Advanced Mechatronics System Design

Course Code: (MTE561)

•General Information About the Course:					
1.	**Course Title:**	**Advanced Mechatronics System Design**			
2.	**Course Code and Number:**	**MTE561**			
3.	**Credit Hours:**	**Credit Hours**			**Total**
		Lecture	Practical	Seminar/Tutorial	
		3	0	0	**3**
4.	**Study Level and Semester:**	**First Semester**			
5.	**Pre-requisites (if any):**	**- Mechatronics System Design** **- Digital Control Systems**			
6.	**Co-requisites (if any):**	**None**			
7.	**Program (s) in which the course is offered:**	MSc. In Mechatronics Engineering Program			
8.	**Language of teaching the course:**	English			
9.	**Study System:**	Courses & Thesis			
10.	**Prepared By:**	Dr. Hatem Al-Dois			
11.	**Reviewed by:**	Dr. ……			
12.	**Date of Approval:**				

•Course Description:

This course aims at helping students to design and obtain a maximum of control of all dynamic aspects of a mechatronics system with a focus on high precision positioning of motion systems. Students will learn full potential of applying mathematical rules in real mechanical designs. The course starts with an introduction that explains the differences in approach towards mechatronics and the Systems Engineering. Then, the responses of mechatronics systems are illustrated with various graphical method representing them. In addition, the characteristics of dynamic motion systems in terms of stiffness, compliance and transmissibility, motion control schemes such as PID, position and velocity control, modern model-based control approaches, and the properties of software used for mechatronics systems are explained. During the course various tasks and assignments are given to reinforce the studied material.

•Course Intended Learning Outcomes (CILOs):

Upon successful completion of Advanced Mechatronics System Design Course, the graduates will be able to:

a1. Explain the methodological fundamentals for the development of optimal control of mechatronics systems.

a2. Describe the dynamic properties, functions and performance of highly integrated precision motion systems.

a3. Comprehend in-depth aspects of different mechatronic system designs and criteria.

a4. Identify various responses and their graphical representation for mechatronics systems.

b1. Analyze and derive improvements to the dynamic behavior of an actuator driven mechanical structures.

b2. Identify the dynamic causes for observed instability issues in controlled motion systems.

b3. Interpret mathematical and theoretical knowledge to design and model effective and optimal mechatronic systems.

c1. Apply optimal PID motion controller settings for a given plant, consisting of a dynamically realistic power amplifier, electromagnetic actuator and mechanical structure with an ideal sensor.

c2. Use computer simulation tools to model and examine mechatronic system designs.

d1. Develop an independent learning capability that leads to a thorough knowledge and practice in the field.

d2. Prepare and deliver high-quality presentations and demonstrate presentation skills.

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

CILOs	PILOs

a. Knowledge and Understanding: Upon successful completion of **the Advanced Mechatronics System Design Course**, the graduates will be able to:		**A. Knowledge and Understanding:** Upon successful completion of the **MSc. In Mechatronics Engineering Program**, the graduates will be able to:
a1.	Explain the methodological fundamentals for the development of optimal control of mechatronics systems.	**A1.** Demonstrate in-depth understanding of applied mathematics in Mechatronics engineering, control system, computer engineering and science, and electronics to design more functional, adaptable and cost-effective products.
a2.	Describe the dynamic properties, functions and performance of highly integrated precision motion systems.	**A2.** Recognize and explain the contemporary engineering technologies and issues in the field of Mechatronics engineering.
a3.	Comprehend in-depth aspects of different mechatronic system designs and criteria.	**A3.** Explain in-depth the principles of sustainable design and development of Mechatronics engineering.
a4.	Identify various responses and their graphical representation for mechatronics systems.	**A4.** Demonstrate research principles and methods applicable to the field of work or academic in Mechatronics engineering and related fields.
b. Cognitive/ Intellectual Skills: Upon successful completion of the **Advanced Mechatronics System Design Course,** the graduates will be able to:		**B. Cognitive/ Intellectual Skills:** Upon successful completion of the **MSc. In Mechatronics Engineering Program,** the graduates will be able to:
b1.	Analyze and derive improvements to the dynamic behavior of an actuator driven mechanical structures.	**B1.** Apply appropriate principles, methodologies, techniques, tools and packages in the analysis, development and evaluation of mechatronics engineering systems.
b2.	Identify the dynamic causes for observed instability issues in controlled motion systems.	**B2.** Identify, formulate and analyze research and solve complex Mechatronics engineering problems.
b3.	Interpret mathematical and theoretical knowledge to design and model effective and optimal mechatronic systems.	**B3.** Design Mechatronics system, component, or process to meet desired needs within realistic constraints.

c. Professional and Practical Skills: Upon successful completion of the **Advanced Mechatronics System Design Course,** the graduates will be able to:		**C. Professional and Practical Skills:** Upon successful completion of the **MSc. In Mechatronics Engineering Program,** the graduates will be able to:
c1.	Apply optimal PID motion controller settings for a given plant, consisting of a dynamically realistic power amplifier, electromagnetic actuator and mechanical structure with an ideal sensor.	**C1.** Conduct research to solve mechatronics engineering problems.
c2.	Use computer simulation tools to model and examine mechatronic system designs.	**C2.** Use advanced methodologies and skills to solve Mechatronics engineering problems.
d. Transferable Skills: Upon successful completion of the **Advanced Mechatronics System Design Course,** the graduates will be able to:		**D. Transferable Skills:** Upon successful completion of the **MSc. In Mechatronics Engineering Program,** the graduates will be able to:
d1.	Develop an independent learning capability that leads to a thorough knowledge and practice in the field.	**D2.** Demonstrate ethical principles, awareness of professional and ethical responsibility as well as knowledge of the standards utilized in related fields.
d2.	Prepare and deliver high-quality presentations and demonstrate presentation skills.	***D3.*** *Conduct independently and communicate research that advances and extends knowledge and scholarship in related fields.*

•Alignment of CILOs to Teaching and Assessment Strategies

a. Alignment of Knowledge and Understanding CILOs:

Knowledge and Understanding CILOs		Teaching Strategies	Assessment Strategies
a1.	Explain the methodological fundamentals for the development of optimal control of mechatronics systems.	▪ Lectures, ▪ Self-Learning Problems/Studies.	▪ Written Exam, ▪ Reports, ▪ Survey, ▪ Assignments
a2.	Describe the dynamic properties, functions and performance of highly integrated precision motion systems.	▪ Lectures, ▪ Self-Learning Problems/Studies, ▪ Case study, ▪ Active learning.	▪ Written Exam, ▪ Reports, ▪ Assignments
a3.	Comprehend in-depth aspects of	▪ Lectures,	▪ Written Exam,

•Alignment of CILOs to Teaching and Assessment Strategies			
	different mechatronic system designs and criteria.	▪ Case study, ▪ Active learning.	▪ Reports, ▪ Assignments
a4.	Identify various responses and their graphical representation for mechatronics system	▪ Lectures, ▪ Case study, ▪ Active learning, ▪ Computer hands-on sessions.	▪ Written Exam, ▪ Assignments
b. Alignment of Intellectual Skills CILOs:			
Intellectual Skills CILOs		**Teaching Strategies**	**Assessment Strategies**
b1.	Analyze and derive improvements to the dynamic behavior of an actuator driven mechanical structures.	▪ Lectures, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Analysis and Problem Solving.	▪ Written Exam, ▪ Assignments
b2.	Identify the dynamic causes for observed instability issues in controlled motion systems.	▪ Lectures, ▪ Case Study, ▪ Simulation Exercises, ▪ Analysis and Problem Solving, ▪ Brainstorming.	▪ Reports, ▪ Written Exam, ▪ Assignments
b3.	Interpret mathematical and theoretical knowledge to design and model effective and optimal mechatronic systems.	▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving.	▪ Written Exam, ▪ Assignments
c. Alignment of Professional and Practical Skills CILOs:			
Professional and Practical Skills CILOs		**Teaching Strategies**	**Assessment Strategies**
c1.	Apply optimal PID motion controller settings for a given plant, consisting of a dynamically realistic power amplifier, electromagnetic actuator and mechanical structure with an ideal sensor.	▪ Case Study, ▪ Simulation Exercises, ▪ Analysis and Problem Solving.	▪ Seminar Report
c2.	Use computer simulation tools to model and examine mechatronic system designs.	▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study.	▪ Seminar Report.
d. Alignment of Transferable (General) Skills CILOs:			
Transferable (General) Skills CILOs		**Teaching Strategies**	**Assessment Strategies**

•Alignment of CILOs to Teaching and Assessment Strategies

d1.	Develop an independent learning capability that leads to a thorough knowledge and practice in the field.	▪ Independent Study, ▪ Presenting Researches.	▪ Assignments, ▪ Survey, ▪ Presentation, ▪ Written Report.
d2.	Prepare and deliver high-quality presentations and demonstrate presentation skills.	▪ Presentation, ▪ Presenting Researches.	▪ Presentation, ▪ Written Report.

•Course Content

1. Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course ILOs
1	**Introduction**	– What is Mechatronic System Design? – Mechatronic system overview	1	3	a1

2	**Systems Engineering and Design**	– Definition and international positioning
		  – Different views on mechatronics
		– Mechatronics and Systems engineering
		  – Definitions and V-model
		  – The product creation process
		  – Requirement budgeting
		  – Roadmapping
		– Design methodology
		  – Concurrent engineering
		  – Modular design with platforms
			2	6	a2, a3

3	**Signals & Plots**	– Signals
		  – Periodic, Harmonic signals
		  – Fourier analysis
		– Dynamic system response to a stimulus
		– Graphical representation
		– Dynamic plots
		  – Laplace & Fourier transform
		  – Time domain
		  – Frequency domain
			2	6	a4

•Course Content

1. Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course ILOs

4	**Dynamic Motion Systems**	– Stiffness in Precision Engineering
		  – Passive and active stiffness
		  – Compliance of dynamic elements
		  – Dynamic modeling of damped mass-spring systems
		– Transmissibility
		– Multi-body dynamics and eigenmodes
		– Standard mechanical frequency responses
			2	6	a2, b3

5	**Mid-Term Exam**	– Previous Topics	1	3	a1, a2, a3, b1, b2, b3

6	**Motion Control I**	– PID - motion control learnt so far
		– Introduction to motion control
		  – Control the trajectory of a machine
		  – Position control
		  – Velocity control (e.g. scanning)
		  – Path planning
		  – Disturbance rejection (vibrations from environment, imperfections of the guidance system, …)
			3	9	a2, b1, b2, b3

7	**Motion Control II**	– Feedforward control
		  – Feedforward control of piezoelectric scanner
		  – Adaptive feedforward control
		– PID feedback control
		– PD – feedback control of CD-player
		– Sensitivity
		– Stability and Robustness
			3	9	a2, a3, b1, b2, b3, c1

•Course Content

1. Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course ILOs
		– PID - feedback control of mass-spring system – PID-control of more complex systems – PID - feedback control of magnetic bearing – How to deal with difficult plants having multiple eigenmodes			
8	**Software in Mechatronics**	– Software in Mechatronics context – Industrial automation – Equipment control – User interfacing – Hardware Software Architecture – Computer architecture, DSP, PLC Communication – PC Vs. PLC – a programming case – PLC / PC programming flavors – Software engineering process – Why designing SW is difficult	1	3	c1, c2
9	**Final Exam**	– All Topics	1	3	a1, a2, a3, a4, b1, b2, c1
Number of Weeks /and Contact Hours Per Semester			**16**	**48**	

2. Practical Aspect

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

3. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Course ILOs
1	None			
Number of Weeks /and Units Per Semester				

•Teaching Strategies:

- Lectures,
- Self-Learning Problems/Studies,
- Case study,
- Active learning,
- Computer hands-on sessions,
- Simulation Exercises,
- Analysis and Problem Solving,
- Brainstorming,
- Independent Study,
- Presenting Researches,
- Presentation.

•Assessment Methods of the Course:

- Reports,
- Survey,
- Written Exam,
- Assignments,
- Seminar Report
- Survey,
- Presentation,
- Written Report.

•Tasks and Assignments:

No.	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)
1	**Literature Survey Paper** Students will pick a mechatronics problem that interests them. The students will be asked to put themselves in the position of authors of a conference or a journal survey paper.	**Individual**	**5**	**7**	a3, b2, d1, d2

•Tasks and Assignments:

No.	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)
	They are supposed to search the literature for approaches to tackle this problem. Then they survey and discuss the relative strengths of each approach. The paper will be 4-6 pages. Student must comply strictly with the formatting instructions using the IEEE template,.				
2	**Paper Critics** The students must pick one of a highly cited paper related to mechatronics (at least 100 citation as per Google Scholar). The students will be asked to put themselves in the position of a reviewer for a conference or journal. They should give constructive feedback to the authors. They will mention also the good and weak aspects of the paper. For every criticism, students will make a suggestion to improve the paper.	**Individual**	**5**	**12**	a3, b1, b2, b3, d1, d2
3	**Mini-project** Projects can be done individually but preferably in group of 2 to 3 students. Students will be requested to select one of the following project types: ***Type A: System Design and Implementation*** - Students identify a problem in a pertinent area of mechatronics, industrial or commercial importance for which there are no available system with reasonable cost and capabilities. This system must contain a combination of mechanical, electronic, computer and control components integrated together in order to solve the problem at hand. - Design and develop a new mechatronics system to solve this problem. - Analyze experimentally or analytically the performance of the developed system. ***Type B: Empirical Evaluation*** - In this type of projects, the student will pick a mechatronics problem that interests him/her. Student	**Group 2-3 students or Individual**	**10**	**15**	a4, b1, b2, b3, c1, c2, d1, d2

•Tasks and Assignments:

No.	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)
	is supposed to search the literature for approaches to tackle this problem, identifies strong and weak points of each approach and selects the most appropriate approach. - He/she must implement and experiment with the selected technique to quantitatively evaluate its performance in tackling the problem. ***Results Delivery:*** - The result of the course project will be a scientific paper (minimum 5 pages) along with part of the source code developed to solve a given problem (if any). - IEEE Manuscript Template must be used.				
Total Score			**20**		

•Learning Assessment:

No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment	CILOs
1	**Tasks and Assignments**	**6, 12, 15**	**20**	**20%**	a3, a4, b1, b2, b3, c1, c2, d1, d2
2	**Midterm Exam (Theoretical)**	**8**	**20**	**20%**	a1, a2, a3, b1, b2, b3
3	**Final Exam (Theoretical)**	**16**	**60**	**60%**	a1, a2, a3, a4, b1, b2, c1
Total			**100**	**100%**	

•Learning Resources :

1. Required Textbook(s) :

1- R. M. Schmidt, G. Schitter & J. EijkThe, 2011, Design of High Performance Mechatronics - High-Tech Functionality by Multidisciplinary System Integration, 1st Edition, The Netherlands, IOS Press.

2- Karl Johan Åström and Richard M. Murray, 2021, Feedback Systems: An Introduction for Scientists and Engineers, 2nd Edition, NJ-USA, Princeton University Press.

2. Essential References:

•Learning Resources :

1- Herman Soemers, 2011, Design Principles for Precision Mechanisms, 1st Edition, The Netherlands, T-Point Print.
2- Anton van Beek, 2009, Advanced Engineering Design – Lifetime Performance and Reliability, 1st Edition, The Netherlands, TU Delft Publications.
3- Gene Franklin, J. David Powell, Michael L. Workman, 2006, Digital Control of Dynamic Systems, 2nd Edition, NY-USA, Addison-Wesley Publishing.
4- Karl Johan Astrom, Bjorn Wittenmark, 2011, Computer-Controlled Systems: Theory and Design, 3rd Edition, NY-USA, Dover Publication.
5- Karl Johan Astrom, Tore Hagglund, 2005, Advanced PID Control, 1st Edition, NC-USA, ISA Publisher.

3. Electronic Materials and Web Sites *etc.*

1- Precision Machine Design
http://www.machinedesign.com
2- Website: Mechatronics Design Center
http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1482
3- Website: Mechatronics Demonstration Kit
http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDoc Name=en023837&part=D
4- Website: Motion system design
http://www.motionsystemdesign.com/
5- Website: Robotics and Mechatronics Network
http://kn.theiet.org/communities/robotics/index.cfm

•الضوابط والسياسات المتبعة في المقرر Course Policies	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
1	**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.**
2	**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.**
3	**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.**
4	**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.**
5	**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.**
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: 2021-2022

Course Plan (Syllabus): Advanced Mechatronics System Design

• Information about Faculty Member Responsible for the Course:

Name	**Dr. Hatem Al-Dois**	**Office Hours**					
Location &Telephone No.	**774677493**	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	**haldois@yah.com**						

• General information about the course:

1.	**Course Title**	**Advanced Mechatronics System Design**			
2.	**Course Code and Number**	**MTE561**			
3.	**Credit Hours**	**Credit Hours**			**Total**
		Lecture	**Practical**	**Seminar/Tutorial**	
		3	0	0	**3**
4.	**Study Level and Semester**	**First Semester**			
5.	**Pre-requisites**	**- Mechatronics System Design** **- Digital Control Systems**			
6.	**Co –requisite**	**None**			
7.	**Program (s) in which the course is offered**	MSc. In Mechatronics Engineering Program			
8.	**Language of teaching the course**	English			
9.	**Location of teaching the course**	Faculty of Engineering, Sana'a University			

•Course Description:

This course aims at helping students to design and obtain a maximum of control of all dynamic aspects of a mechatronics system with a focus on high precision positioning of motion systems. Students will learn full potential of applying mathematical rules in real mechanical designs. The course starts with an introduction that explains the differences in approach towards mechatronics and the Systems Engineering. Then, the responses of mechatronics systems are illustrated with various graphical method representing them. In addition, the characteristics of dynamic motion systems in terms of stiffness, compliance and transmissibility, motion control schemes such as PID, position and velocity control, modern model-based control approaches, and the properties of software used for mechatronics systems are explained. During the course various tasks and assignments are given to reinforce the studied material.

•Course Intended Learning Outcomes (CILOs):

Upon successful completion of Advanced Mechatronics System Design Course, the graduates will be able to:

a1. Explain the methodological fundamentals for the development of optimal control of mechatronics systems.

a2. Describe the dynamic properties, functions and performance of highly integrated precision motion systems.

a3. Comprehend in-depth aspects of different mechatronic system designs and criteria.

a4. Identify various responses and their graphical representation for mechatronics systems.

b1. Analyze and derive improvements to the dynamic behavior of an actuator driven mechanical structures.

b2. Identify the dynamic causes for observed instability issues in controlled motion systems.

b3. Interpret mathematical and theoretical knowledge to design and model effective and optimal mechatronic systems.

c1. Apply optimal PID motion controller settings for a given plant, consisting of a dynamically realistic power amplifier, electromagnetic actuator and mechanical structure with an ideal sensor.

c2. Use computer simulation tools to model and examine mechatronic system designs.

d1. Develop an independent learning capability that leads to a thorough knowledge and practice in the field.

d2. Prepare and deliver high-quality presentations and demonstrate presentation skills.

•Course Content

- **Theoretical Aspect**

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

•Course Content

- **Theoretical Aspect**

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours
1	**Introduction**	– What is Mechatronic System Design? – Mechatronic system overview	1	3
2	**Systems Engineering and Design**	– Definition and international positioning – Different views on mechatronics – Mechatronics and Systems engineering – Definitions and V-model – The product creation process – Requirement budgeting – Roadmapping – Design methodology – Concurrent engineering – Modular design with platforms	2	6
3	**Signals & Plots**	– Signals – Periodic, Harmonic signals – Fourier analysis – Dynamic system response to a stimulus – Graphical representation – Dynamic plots – Laplace & Fourier transform – Time domain – Frequency domain	2	6
4	**Dynamic Motion Systems**	– Stiffness in Precision Engineering – Passive and active stiffness – Compliance of dynamic elements – Dynamic modeling of damped mass-spring systems – Transmissibility – Multi-body dynamics and eigenmodes – Standard mechanical frequency responses	2	6
5	**Mid-Term Exam**	– Previous Topics	1	3
6	**Motion Control I**	– PID - motion control learnt so far – Introduction to motion control – Control the trajectory of a machine – Position control – Velocity control (e.g. scanning)	3	9

•Course Content

- **Theoretical Aspect**

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours
		– Path planning – Disturbance rejection (vibrations from environment, imperfections of the guidance system, …)		
7	**Motion Control II**	– Feedforward control – Feedforward control of piezoelectric scanner – Adaptive feedforward control – PID feedback control – PD – feedback control of CD-player – Sensitivity – Stability and Robustness – PID - feedback control of mass-spring system – PID-control of more complex systems – PID - feedback control of magnetic bearing – How to deal with difficult plants having multiple eigenmodes	3	9
8	**Software in Mechatronics**	– Software in Mechatronics context – Industrial automation – Equipment control – User interfacing – Hardware Software Architecture – Computer architecture, DSP, PLC Communication – PC Vs. PLC – a programming case – PLC / PC programming flavors – Software engineering process – Why designing SW is difficult	1	3
9	**Final Exam**	– All Topics	1	3
Number of Weeks /and Contact Hours Per Semester			**16**	**48**

- **Practical Aspect**

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

- **Tutorial Aspect:**

No.	Tutorial	Number of Weeks	Contact Hours
1	None		
Number of Weeks /and Units Per Semester			

•Teaching Strategies:

- Lectures,
- Self-Learning Problems/Studies,
- Case study,
- Active learning,
- Computer hands-on sessions,
- Simulation Exercises,
- Analysis and Problem Solving,
- Brainstorming,
- Independent Study,
- Presenting Researches,
- Presentation.

•Assessment Methods of the Course:

- Reports,
- Survey,
- Written Exam,
- Assignments,
- Seminar Report
- Survey,
- Presentation,
- Written Report.

•Tasks and Assignments:

No.	Assignments/ Tasks	Individual/ Group	Mark	Week Due
1	**Literature Survey Paper** Students will pick a mechatronics problem that interests them. The students will be asked to put themselves in the position of authors of a conference or a journal survey paper. They are supposed to search the literature for approaches to tackle this problem. Then they survey and discuss the relative strengths of each approach. The paper will be 4-6 pages. Student must comply strictly with the formatting instructions using the IEEE template,.	**Individual**	**5**	**7**
2	**Paper Critics** The students must pick one of a highly cited paper related to mechatronics (at least 100 citation as per Google Scholar). The students will be asked to put themselves in the position of a reviewer for a conference or journal. They should give constructive feedback to the authors. They will mention also the good and weak aspects of the paper. For every criticism, students will make a suggestion to improve the paper.	**Individual**	**5**	**12**
3	**Mini-project** Projects can be done individually but preferably in group of 2 to 3 students. Students will be requested to select one of the following project types: ***Type A: System Design and Implementation*** - Students identify a problem in a pertinent area of mechatronics, industrial or commercial importance for which there are no available system with reasonable cost and capabilities. This system must contain a combination of mechanical, electronic, computer and control components integrated together in order to solve the problem at hand. - Design and develop a new mechatronics system to solve this problem. - Analyze experimentally or analytically the performance of the developed system. ***Type B: Empirical Evaluation*** - In this type of projects, the student will pick a mechatronics	**Group 2-3 students or Individual**	**10**	**15**

•Tasks and Assignments:

No.	Assignments/ Tasks	Individual/ Group	Mark	Week Due
	problem that interests him/her. Student is supposed to search the literature for approaches to tackle this problem, identifies strong and weak points of each approach and selects the most appropriate approach. - He/she must implement and experiment with the selected technique to quantitatively evaluate its performance in tackling the problem. ***Results Delivery:*** - The result of the course project will be a scientific paper (minimum 5 pages) along with part of the source code developed to solve a given problem (if any). - IEEE Manuscript Template must be used.			
Total Score			**20**	

•Learning Assessment:

No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment
1	**Tasks and Assignments**	**6, 12, 15**	**20**	**20%**
2	**Midterm Exam (Theoretical)**	**8**	**20**	**20%**
3	**Final Exam (Theoretical)**	**16**	**60**	**60%**
Total			**100**	**100%**

•Learning Resources :

1. Required Textbook(s) :

1- R. M. Schmidt, G. Schitter & J. EijkThe, 2011, Design of High Performance Mechatronics - High-Tech Functionality by Multidisciplinary System Integration, 1st Edition, The Netherlands, IOS Press.

2- Karl Johan Åström and Richard M. Murray, 2021, Feedback Systems: An Introduction for Scientists and Engineers, 2nd Edition, NJ-USA, Princeton University Press.

2. Essential References:

1- Herman Soemers, 2011, Design Principles for Precision Mechanisms, 1st Edition, The

•Learning Resources :

Netherlands, T-Point Print.
2- Anton van Beek, 2009, Advanced Engineering Design – Lifetime Performance and Reliability, 1st Edition, The Netherlands, TU Delft Publications.
3- Gene Franklin, J. David Powell, Michael L. Workman, 2006, Digital Control of Dynamic Systems, 2nd Edition, NY-USA, Addison-Wesley Publishing.
4- Karl Johan Astrom, Bjorn Wittenmark, 2011, Computer-Controlled Systems: Theory and Design, 3rd Edition, NY-USA, Dover Publication.
5- Karl Johan Astrom, Tore Hagglund, 2005, Advanced PID Control, 1st Edition, NC-USA, ISA Publisher.

3. Electronic Materials and Web Sites *etc.*

1- Precision Machine Design
http://www.machinedesign.com
2- Website: Mechatronics Design Center
http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1482
3- Website: Mechatronics Demonstration Kit
http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDoc Name=en023837&part=D
4- Website: Motion system design
http://www.motionsystemdesign.com/
5- Website: Robotics and Mechatronics Network
http://kn.theiet.org/communities/robotics/index.cfm

•الضوابط والسياسات المتبعة في المقرر Course Policies

يعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:

1	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.
2	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.
3	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.
4	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.
5	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.
6	الانتحال Plagiarism:

•الضوابط والسياسات المتبعة في المقرر Course Policies	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
	– 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