40.Course Specification of Digital Control System

I.Course Identification and General Information:

.1	Course Title:	Digital Control System.				
.2	Course Code & Number:	MT301.				
.3	Credit hours:	C.H.				TOTAL CR. Hrs.
		Th.	Seminar	Pr.	Tu.	
		2	-		-	3
.4	Study Level/ Semester at which this Course is offered:	Fourth Year- First Semester.				
.5	Pre –Requisite (if any):	Analog Control System.				
.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. Mohammed Abdullah Al-Olofi.				
11.	Date of Approval:					

II.Course Description:

The course introduces the basic concepts of modern control systems – the basic principles of digital control systems – quantization and quantization errors – data acquisitions – Z-transform – Inverse Z- transform – Z- transform method to solve the difference equations – Z plane analysis for discrete time control systems – impulse sampling – pulse transfer function – PID digital controllers - realization and implementation of digital controllers – mapping between continuous –time control systems and discrete-time control systems – stability analysis – transient and steady state response of digital control systems - basic concepts of conventional and modern design methods of digital control systems – design based on the root-locus method – bode plot - design based on the frequency response methods– analytical design methods – state space representation of discrete-time control systems – solving the discrete-time state space equations – controllability – observability – useful transformations in state space analysis and design – pole placement design method – observer design – servo-controller.

III.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Describe the concepts and the mathematical modeling of digital feedback control systems in pulse transfer function model and state variable model.	A1
a2.	Explain basic principles, components of digital control systems, and application of digital control systems in mechatronics.	A2
b1.	Analyze the mechatronics engineering systems using modern digital control engineering tools.	B1
b2.	Design digital controllers and other components of mechatronics products using digital control system design methods.	B5
c1.	Apply the digital control system tools to measure and evaluate mechatronics systems performance.	C1
c2.	Apply the information technology tools to solve digital control systems problems in the field of mechatronics.	C2
c3.	Implement the digital controllers of digital feedback control systems using the software and hardware realization methods.	C3
d1.	Co-operate productively as an individual and as a member of a team / multi-disciplinary team.	D1
d2.	Review effective technical reports and presentations.	D2
d3.	Evaluate effectively project tasks, time and resources.	D3
d4.	Assess to independent lifelong learning.	D5

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
a1. Describe the concepts and the mathematical modeling of digital feedback control systems in pulse transfer function model and state variable model.	• Active Lectures. • Tutorials.	• Written Assessment. • Short Essays.
a2. Explain basic principles, components of digital control systems, and application of digital control systems in mechatronics.	• Active Lectures. • Case Studies. • Hands on Laboratory Work.	• Written Assessment. • Practical Assessment. • Simulations.

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

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Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
b1. Analyze the mechatronics engineering systems using modern engineering tools. digital control	• Group Learning and Problem-Based Learning. • Independent Applications of Engineering Analysis. • Case Studies.	• Practical Assessment. • Project Reports. • Laboratory Reports.
b2. Design digital controllers and other components of mechatronics products using digital control system design methods.	• Group Learning and Problem-Based Learning • Hands-on Laboratory Work. • Case Studies.	• Written Assessment. • Project Reports. • Case Studies.

(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. Apply the digital control system tools to measure and evaluate performance.mechatronics systems	• Hands-on Laboratory Work. • Design Work and Projects.	• Practical Assessment. • Laboratory Reports.
c2. Apply the information technology tools to solve digital control systems problems in the field of mechatronics..	• The Use of Communication and Information Technology. • Computer and Web-Based Learning.	• Simulations such as Computer Based Learning.
c3. Implement the digital controllers of digital feedback control systems using the software and hardware realization methods.	• Hands-on Laboratory Work. • Independent Learning and Work.	• Practical Assessment. • Project Reports. • Case Studies.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
d1. Co-operate productively as an individual and as a member of a team / multi-disciplinary team.	• Hands-on Laboratory Work. • Group Learning.	• Project Reports.
d2. Review effective technical reports and presentations.	• Hands-on Laboratory Work.	• Project Reports. • Laboratory Reports.

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		• Presentations.
d3. Evaluate effectively project tasks, time and resources.	• Hands-on Laboratory Work. • Design Work and Projects.	• Presentations.
d4. Assess to independent lifelong learning.	• Independent Learning and Work. • Directed Self-Study.	• Written Assessments. • Presentations.

IV.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction to Discrete- Time Control Systems.	a1, a2	Introduction of digital control systems, types of digital control systems, quantization methods, data acquisition.	1	2
2.	The Z-Transform.	a1, a2, b1, c1	Introduction, Z-transform, Z-transform of elementary function, properties and theorems of z-transform, Inverse Z-transform, solve the difference equations of digital control systems, example problems and solutions.	1	2
3.	The Z-Plane Analysis of Discrete-Time Control Systems.	a1, a2, b1, c1	Impulse sampling and data holding, components of digital control systems, pulse transfer function, reduction block diagram in digital control systems, example problems and solutions.	1	2
4.	The Z-Plane Analysis of Discrete-Time Control Systems.	a1, a2, b1, c1	PID digital controllers, realization and implementation of digital controllers,	1	2

			microcontroller implementation to digital controllers, select the sampling interval, example problems and solutions.		
5.	Design of Discrete-Time Control Systems by the Conventional Methods.	a1, a2, b1, c1, d4	Introduction to design methods, mapping between s-plane and z-plane, example problems and solutions.	1	2
6.	Design of Discrete-Time Control Systems by the Conventional Methods	a1, a2, b1, c1, d4	Transient and steady state response analysis of feedback digital control systems, example problems and solutions..	1	2
7.	Design of Discrete-Time Control Systems by the Conventional Methods.	a1, a2, b1, b2, c1,c2, c3, d2, d4	Introduction to conventional design methods, the root locus method, design based the root locus method, example problems and solutions.	1	2
8.	Mid Term Exam.	a1, a2, b1, b2, c1,c2, c3	The First 7 Chapters.	1	2
9.	Design of Discrete-Time Control Systems by the Conventional Methods.	a1, a2, b1, b2, c1,c2, c3, d2, d4	Frequency response methods, bode plot, design based on the Frequency response methods, example problems and solutions.	1	2
10.	Design of Discrete-Time Control Systems by the Conventional Methods.	a1, a2, b1, b2, c1,c2, c3, d2, d4	Analytical design methods,, dead beat response design methods, example problems and solutions.	1	2
11.	State Space Analysis.	a1, a2, b1, b2, c1,c2, c3, d2, d4	State space representation of discrete-time control systems, solving the	1	2

			discrete-time state space equations, design example problems and solutions.		
12.	Pole Placement and Observer Design (Modern Design Methods).	a1, a2, b1, b2, c1,c2, c3, d2, d4	Controllability, observability, useful transformations in state space analysis, design example problems and solutions.	1	2
13.	Pole Placement and Observer Design (Modern Design Methods).	a1, a2, b1, b2, c1,c2, c3, d2, d4	Pole placement design method, example problems and solutions.	1	2
14.	Pole Placement and Observer Design (Modern Design Methods).	a1, a2, b1, b2, c1,c2, c3, d2, d4	Observer design method, example problems and solutions..	1	2
15.	Pole Placement and Observer Design (Modern Design Methods).	a1, a2, b1, b2, c1,c2, c3, d2, d4	Servo-controller design method, example problems and solutions..	1	2
16.	Final Exam	a1, a2, b1, b2, c1,c2, c3	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes
1.	Introduction of digital control systems with Matlab software.	1	2	a1, d4
2.	Discrete-time control systems simulation and Simulink.	1	2	a2, c2, d2, d4
3.	Time-domain digital controller emulation.	1	2	a2, c1, c2, b2, d2, d4

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4.	Frequency-domain digital controller emulation.	1	2	a2, c1, c2, b2, d2, d4
5.	Sampling, aliasing, zero-order hold (Simulink).	1	2	a2, c1, c2, b2, d2, d4
6.	Discrete-time plant modeling.	1	2	a2, c1, c2, b2, d2, d4
7.	Mid- Term Practical Exam.	1	2	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
8.	Root-locus, frequency response design methods for digital controllers.	1	2	a2, c1, c2, b2, d1, d2, d3, d4
9.	Numerical optimal PID digital controller design in Matlab program.	1	2	a2, c1, c2, b2, d1, d2, d3, d4
10.	State-space digital controllers design in Matlab program.	2	4	a2, c1, c2, b2, d1, d2, d3, d4
11.	Introduction to Arduino IDE.	1	2	a2, c1, c2, b2, d1, d2, d3, d4
12.	Implementation the digital controller with microcontroller by using the MikroC and Proteus simulation software.	1	2	a2, c1, c2, b2, d1, d2, d3, d4
13.	Final Practical Exam.	1	2	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
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 (supported with discussions).
- Tutorials.
- Hands-on Laboratory Work.
- Independent Learning and Work.
- Group Learning and Problem-Based Learning.
- Independent Applications of Engineering Analysis.
- Computer and Web-Based Learning.
- Case Studies.
- Design Work and Projects.
- Directed Self-Study.

VI.Assessment Methods of the Course:

The assessment methods of the course are as follows:

- Short essays.
- Written Assessments.
- Simulations.
- Practical Assessment.
- Project Reports.
- Laboratory Reports.
- Case Studies.
- Presentations.

VII.Assignments:

Order	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1.	Problems, and advance problems, and computer problems of the Chapter 2	a1, a2, b1, c1	2	1.5
2.	Problems, and advance problems, and computer problems of the Chapter 3	a1, a2, b1, c1, c2, d2, d4	5	1.5
3.	Problems, and advance problems, and computer problems of the Chapter 4	a1, a2, b1, c1, c2, d2, d4	8	1.5
4.	Problems, and advance problems, and computer problems of the Chapter 5	a1, a2, b1,b2, c1, c2 c3, d2, d4	12	1.5
5.	Problems, and advance problems, and computer problems of the Chapter 6	a1, a2, b1,b2, c1, c2 c3, d2, d4	14	1.5
Total				**7.5**

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

Order	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Quizzes.	3, 6, 9, 11	7.5	5%	a1, a2, b1, b2, c1,c2, c3, d2, d4
2.	Assignments & Home-works.	2, 5, 8, 12, 14	7.5	5%	a1, a2, b1, b2, c1,c2, c3, d2, d4
3.	Mid-Term Practical Exam.	7	7.5	5%	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4

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4.	Mid-Term Theoretical Exam.	8	7.5	5%	a1, a2, b1, b2, c1,c2, c3
5.	Practical Projects.	12	15	10%	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
6.	Final Exam Practical.	15	15	10%	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
7.	Final Exam Theoretical.	16	90	60%	a1, a2, b1, b2, c1,c2, c3
Total			**150**	**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. Katsuhiko Ogata, 2010, Discrete-time Control Systems, 2nd Edition, NJ-USA, Prentice Hall.
2. Dogan Ibrahim, 2006, Microcontroller Based Applied a Digital Controller, 1st Edition, NY-USA, John Wiley & Sons Inc.

2- Essential References.

1. M. Sam Fadali, 2009, Digital Control Systems Analysis And Design, 1st Edition, UK, Elsevier Inc.
2. C. L. Philips and H. T. Nagle, 1995, Digital Control System Analysis and Design, 3rd edition, Prentice Hall, Englewood Cliffs, N.J., USA.
3. Steven Karris, 2011, Introduction to Simulink with Engineering Applications, 2nd Ed., Orchard Publications, UK.

3- Electronic Materials and Web Sites etc.

1. National Instruments
   https://learn.ni.com/teach/resources/1221/digital-control
2. MIT Open Course Ware , Analysis and Design of Digital Control Systems
   https://ocw.mit.edu/courses/mechanical-engineering/2-171-analysis-and-design-of-digital-control-systems-fall-2006/
3. Purdue University | Purdue Online Learning, College of Engineering, Digital Control
   https://engineering.purdue.edu/ProEd/courses/digital-control
4. http://www.sciencedirect.com/
5. http://dl.acm.org/dl.cfm
6. http://ieeexplore.ieee.org/Xplore/guesthome.jsp
7. http://www.emeraldinsight.com
8. http://www.scopus.com/home.url

	9. http://link.springer.com/

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 the examination committee for enquiries . he has to face
6.	**Plagiarism**: The student will be terminated from the Faculty, if one student 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.

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

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Course Plan of Digital Control System

I.Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Asst. Prof. Dr. Mohammed Abdullah Al-Olofi	**Office Hours**					
Location& Telephone No.	00967-773703712	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	Al_olfe2001@yahoo.com						

II.Course Identification and General Information:

.1	Course Title:	Digital Control System.				
.2	Course Code & Number:	MT301.				
.3	Credit hours:	C.H.				TOTAL Cr. Hrs.
		Th.	Seminar	Pr.	Tu.	
		2	-	2	-	3
.4	Study Level/ Semester at which this Course is offered:	Fourth Year- First Semester.				
.5	Pre –Requisite (if any):	Analog Control System.				
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	System of Study:	Semesters.				
.10	Mode of Delivery:	Lectures and Labs.				
11.	Location of Teaching the Course:	Mechatronics Engineering Department.				

III.Course Description:

The course introduces the basic concepts of modern control systems – the basic principles of Digital control systems – Quantization and quantization errors – data acquisitions – Z-transform – Inverse Z- transform – Z- transform method to solve the difference equations – Z plane analysis for discrete time control systems – impulse sampling – pulse transfer function – PID digital

controllers - realization and implementation of digital controllers – mapping between continuous –time control systems and discrete-time control systems – stability analysis – transient and steady state response of digital control systems - basic concepts of conventional and modern design methods of digital control systems – design based on the root-locus method – bode plot - design based on the frequency response methods– analytical design methods – state space representation of discrete-time control systems – solving the discrete-time state space equations – controllability – observability – useful transformations in state space analysis and design – pole placement design method – observer design – servo-controller.

IV.Course Intended learning outcomes (CILOs) of the course		**Referenced PILOs**
a1.	Describe the concepts and the mathematical modeling of digital feedback control systems in pulse transfer function model and state variable model.	A1
a2.	Explain basic principles, components of digital control systems, and application of digital control systems in mechatronics.	A2
b1.	Analyze the mechatronics engineering systems using modern digital control engineering tools.	B1
b2.	Design digital controllers and other components of mechatronics products using digital control system design methods.	B5
c1.	Apply the digital control system tools to measure and evaluate mechatronics systems performance.	C1
c2.	Apply the information technology tools to solve digital control systems problems in the field of mechatronics.	C2
c3.	Implement the digital controllers of digital feedback control systems using the software and hardware realization methods.	C3
d1.	Co-operate productively as an individual and as a member of a team / multi-disciplinary team.	D1
d2.	Review effective technical reports and presentations.	D2
d3.	Evaluate effectively project tasks, time and resources.	D3
d4.	Assess to independent lifelong learning.	D5

V.Course Content:

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

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction to Discrete- Time Control Systems.	Introduction of digital control systems, types of digital control systems, quantization methods, data acquisition.	1	2
2.	The Z-Transform.	Introduction, Z-transform, Z-transform of elementary function, properties and theorems of z-transform, Inverse Z-transform, solve the difference equations of digital control systems, example problems and solutions.	2	2
3.	The Z-Plane Analysis of Discrete-Time Control Systems.	Impulse sampling and data holding, components of digital control systems, pulse transfer function, reduction block diagram in digital control systems, example problems and solutions.	3	2
4.	The Z-Plane Analysis of Discrete-Time Control Systems.	PID digital controllers, realization and implementation of digital controllers, microcontroller implementation to digital controllers, select the sampling interval, example problems and solutions.	4	2
5.	Design of Discrete-Time Control Systems by the Conventional Methods.	Introduction to design methods, mapping between s-plane and z-plane, example problems and solutions.	5	2
6.	Design of Discrete-Time Control Systems by the Conventional Methods	Transient and steady state response analysis of feedback digital control systems, example problems and solutions..	6	2
7.	Design of Discrete-Time Control Systems by the Conventional Methods.	Introduction to conventional design methods, the root locus method, design based the root locus method, example problems and solutions.	7	2
8.	Mid Term Exam.	The First 7 Chapters.	8	2

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9.	Design of Discrete-Time Control Systems by the Conventional Methods.	Frequency response methods, bode plot, design based on the Frequency response methods, example problems and solutions.	9	2
10.	Design of Discrete-Time Control Systems by the Conventional Methods.	Analytical design methods,, dead beat response design methods, example problems and solutions.	10	2
11.	State Space Analysis.	state space representation of discrete-time control systems, solving the discrete-time state space equations, design example problems and solutions.	11	2
12.	Pole Placement and Observer Design (Modern Design Methods).	Controllability, observability, useful transformations in state space analysis, design example problems and solutions.	12	2
13.	Pole Placement and Observer Design (Modern Design Methods).	Pole placement design method, example problems and solutions.	13	2
14.	Pole Placement and Observer Design (Modern Design Methods).	observer design method, example problems and solutions.	14	2
15.	Pole Placement and Observer Design (Modern Design Methods).	Servo-controller design method, example problems and solutions..	15	2
16.	Final Exam.	All the Chapters.	16	2
		Number of Weeks /and Units Per Semester	**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes

1.	Introduction of digital control systems with Matlab software.	1	2	a1, d4
2.	Discrete-time control systems simulation and Simulink.	2	2	a2, c2, d2, d4
3.	Time-domain digital controller emulation.	3	2	a2, c1, c2, b2, d2, d4
4.	Frequency-domain digital controller emulation.	4	2	a2, c1, c2, b2, d2, d4
5.	Sampling, aliasing, zero-order hold (Simulink).	5	2	a2, c1, c2, b2, d2, d4
6.	Discrete-time plant modeling.	6	2	a2, c1, c2, b2, d2, d4
7.	Mid- Term Practical Exam.	7	2	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
8.	Root-locus, frequency response design methods for digital controllers.	8	2	a2, c1, c2, b2, d1, d2, d3, d4
9.	Numerical optimal PID digital controller design in Matlab program.	9	2	a2, c1, c2, b2, d1, d2, d3, d4
10.	State-space digital controllers design in Matlab program.	10,11	4	a2, c1, c2, b2, d1, d2, d3, d4
11.	Introduction to Arduino IDE.	12	2	a2, c1, c2, b2, d1, d2, d3, d4
12.	Implementation the digital controller with microcontroller by using the MikroC and Proteus simulation software.	13	2	a2, c1, c2, b2, d1, d2, d3, d4
13.	Final Practical Exam.	14	2	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
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 (supported with discussions).
- Tutorials.
- Hands-on Laboratory Work.
- Independent Learning and Work.
- Group Learning and Problem-Based Learning.
- Independent Applications of Engineering Analysis.
- Computer and Web-Based Learning.

- Case Studies.
- Design Work and Projects.
- Directed Self-Study.

VII.Assignments:

Order	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1.	Problems, and advance problems, and computer problems of the Chapter 2	a1, a2, b1, c1	2	1.5
2.	Problems, and advance problems, and computer problems of the Chapter 3	a1, a2, b1, c1, c2, d2, d4	5	1.5
3.	Problems, and advance problems, and computer problems of the Chapter 4	a1, a2, b1, c1, c2, d2, d4	8	1.5
4.	Problems, and advance problems, and computer problems of the Chapter 5	a1, a2, b1,b2, c1, c2 c3, d2, d4	12	1.5
5.	Problems, and advance problems, and computer problems of the Chapter 6	a1, a2, b1,b2, c1, c2 c3, d2, d4	14	1.5
Total				**7.5**

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

Order	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Quizzes.	3, 6, 9, 11	7.5	5%	a1, a2, b1, b2, c1,c2, c3, d2, d4
2.	Assignments & Home-works.	2, 5, 8, 12, 14	7.5	5%	a1, a2, b1, b2, c1,c2, c3, d2, d4
3.	Mid-Term Practical Exam.	7	7.5	5%	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
4.	Mid-Term Theoretical Exam.	8	7.5	5%	a1, a2, b1, b2, c1,c2, c3
5.	Practical Projects.	12	15	10%	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
6.	Final Exam Practical.	15	15	10%	a1, a2, b1, b2, c1,c2, c3, d1, d2, d3, d4
7.	Final Exam Theoretical.	16	90	60%	a1, a2, b1, b2, c1,c2, c3

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

Total	**150**	**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. Katsuhiko Ogata, 2010, Discrete-time Control Systems, 2nd Edition, NJ-USA, Prentice Hall.
2. Dogan Ibrahim, 2006, Microcontroller Based Applied a Digital Controller, 1st Edition, NY-USA, John Wiley & Sons Inc.

2- Essential References.

1. M. Sam Fadali, 2009, Digital Control Systems Analysis And Design, 1st Edition, UK, Elsevier Inc.
2. C. L. Philips and H. T. Nagle, 1995, Digital Control System Analysis and Design, 3 rd edition, Prentice Hall, Englewood Cliffs, N.J., USA.
3. Steven Karris, 2011, Introduction to Simulink with Engineering Applications, 2nd Ed., Orchard Publications, UK.

3- Electronic Materials and Web Sites etc.

1. National Instruments
   https://learn.ni.com/teach/resources/1221/digital-control
2. MIT Open Course Ware , Analysis and Design of Digital Control Systems
   https://ocw.mit.edu/courses/mechanical-engineering/2-171-analysis-and-design-of-digital-control-systems-fall-2006/
3. Purdue University | Purdue Online Learning, College of Engineering, Digital Control
   https://engineering.purdue.edu/ProEd/courses/digital-control
4. http://www.sciencedirect.com/
5. http://dl.acm.org/dl.cfm
6. http://ieeexplore.ieee.org/Xplore/guesthome.jsp
7. http://www.emeraldinsight.com
8. http://www.scopus.com/home.url
9. http://link.springer.com/

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.