Republic of Yemen

Ministry of Higher Education & Scientific Research

21 SEPTEMBER UNIVERSITY for MEDICALS & APPLIEED SCIENCES

Faculty of

Engineering and Computer

Department of Biomedical Engineering

Course Specification of

Digital control System

Course No. 07.02.733

2022/2023

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

I. Course Identification and General Information:

1	Course Title:	Digital control System			
2	Course Code & Number:	07.02.733			
3	Credit Hours:	Credit Hours	Theory Hours		Lab. Hours
			Lecture	Exercise	
		3	2	--	1
4	Study Level/ Semester at which this Course is offered:	3 Level / 2 Semester			
5	Pre –Requisite (if any):	Analog Control Systems			
6	Co –Requisite (if any):	Microprocessor and Microcontrollers			
7	Program (s) in which the Course is Offered:	Biomedical Engineering Technology			
8	Language of Teaching the Course:	English			
9	Study System:	Regular (semester)			
10	Mode of Delivery:				
11	Location of Teaching the Course:	University Campus			
12	Prepared by:	Dr. AMMAR ALI ALI ABDU			
13	Date of Approval:				

II. Course Description:

The Digital Control Systems course aims to give the student knowledge of the basic concepts and Theories of modeling, development, analysis, design and implement of modern and digital control systems. This course includes the basic principles of digital control systems, quantization and quantization errors, data acquisitions, Z-transform and its applications to solve difference equations, Z plane analysis for discrete time control systems, impulse sampling, pulse transfer function, PID digital controllers realization and implementation, mapping between continuous –time control systems and discrete-time control systems, stability analysis, transient and steady state response, conventional and modern design methods of digital control systems, root-locus and bode plot design methods, analytical design methods, state space representation, controllability, observability, and servo-controllers. The practical part allows students to practice different digital control approaches studied in theoretical classes.

III. Course Intended Learning Outcomes (CILOs) : مخرجات تعلم المقرر))		Referenced PILOs مخرجات تعلم البرنامج))	
A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:			
a1	Explain how different analysis techniques are used to determine the specifications of digital control systems, and common design methods for design a digital controllers.	A1	Explain the appropriate models, theories, mathematical foundations, and techniques related to biomedical engineering technology context.
a2	Understand the concepts, theories, and mathematical modeling of Digital systems in pulse transfer function model and state variable model.	A4	Understand an examples of a biomedical engineering technology concept and methods related to maintenance, measurement techniques, programming, creative engineering solutions, analytical skills, applied to healthcare quality and problems of medical devices issues.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:			
b1	Analysis, and evaluate the biomedical engineering systems using the modern control engineering tools, then select a	B2	Analyze the impacts of problems related to the Biomedical equipments and its solution principles in a creative manner by

	suitable digital controller for biomedical systems.		using a systematic and analytical thinking methods.
b2	Design the digital controllers, and others components of the medical devices by using the control system design methods..	B3	Assess the features of biomedical devices systems, engineering diagnostic skills, technological expertise, and analytical methods that related to identify and addressing of biomedical devices systems failures.
b3	Apply common conventional and modern engineering methods to model, analyze, and organize the digital biomedical systems.	B4	Apply the principles of biomedical devices maintenance and its various methods to work professionally in biomedical engineering field.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:			
c1	Use the modern engineering tools, and analytical techniques to evaluate performance characteristics of different types of plant and process, and applying the knowledge to design, and implement a digital control systems.	C1	Relate integrally knowledge of life science, biomedical engineering technology practice concepts, principles of engineering and techniques evaluation to solve problems relevant to biomedical engineering.
c2	Conduct appropriate experimentation related to a digital control systems, and Locate different type of digital controllers used in real medical equipment.	C2	Evaluate an engineering technique, modern analytical tools and required computer programs to analyzing and solve the problems of medical devices.
D. Transferable Skills: Upon successful completion of the course, students will be able to:			
d1	Lead, and work productively as an individual and as a member of a team / multi-disciplinary team.	D1	Function effectively as an individual, team member, or leader in activities relevant to biomedical engineering, and collaborating to achieve a shared objective.

(A) Alignment of Course Intended Learning Outcomes (Knowledge and Understanding) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
a1	Understand the concepts, theories, and mathematical modeling of Digital systems in pulse transfer function model and state variable model.	• Interactive lectures & • examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class • discussions, • Case studies, • Exercises and home • works, • Computer laboratory • based sessions, • Directed self- study, • Problem based learning, • Mini/major project.	• Written tests (mid and • final terms and • quizzes), • Short reports, • Practical lab • performance • assessment, • Coursework activities • assessment, • Home works and • assignments, • Presentations.
a2	Explain how different analysis techniques are used to determine the specifications of digital control systems, and common design methods for design a digital controllers.		
(B) Alignment of Course Intended Learning Outcomes (Intellectual Skills) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	**Teaching Strategies**	**Assessment Strategies**
b1	Apply common conventional and modern engineering methods to model, analyze, and organize the digital biomedical systems.	• Interactive lectures & • examples, • Tutorials, • Videos demonstrations,	• Written tests (mid and • final terms and • quizzes), • Short reports, • Lab\Project report

b2	Analysis, and evaluate the biomedical engineering systems using the modern control engineering tools, then select a suitable digital controller for biomedical systems.	• Presentation/seminar, • Interactive class • discussions, • Case studies, • Exercises and home • works, • Laboratory/Practical • experiments based • session, • Computer laboratory • based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Mini/major project.	• Practical lab • performance • assessment, • Coursework activities
b3	Design the digital controllers, and others components of the medical devices by using the control system design methods.system design methods.		• assessment, • Home works and • assignments, • Presentations.

(C) Alignment of Course Intended Learning Outcomes (Professional and Practical Skills) to Teaching Strategies and Assessment Methods:

	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
c1	Use the modern engineering tools, and analytical techniques to evaluate performance characteristics of different types of plant and process, and applying the knowledge to design, and implement a digital control systems.	• Interactive lectures & • examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class • discussions, • Case studies, • Exercises and home • works, • Computer laboratory • based sessions, • Directed self- study, • Problem based learning, • Mini/major project.	• Written tests (mid and • final terms and • quizzes), • Short reports, • Practical lab • performance • assessment, • Coursework activities • assessment, • Home works and • assignments, • Presentations.
c2	Conduct appropriate experimentation related to a digital control systems, and Locate different type of digital controllers used in real medical equipment		

(D) Alignment of Course Intended Learning Outcomes (Transferable Skills) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
d1	Lead, and work productively as an individual and as a member of a team / multi-disciplinary team.	▪ Small group discussion	▪ Presentation

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	Introduction to discrete- time control systems	• Introduction of digital control systems, • types of digital control systems, quantization methods, • data acquisition.	1	2	a1, a2
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	1	2	a1, a2

		solutions.			
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.	1	2	a1, a2, b1, b2, b3
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.	1	2	a1, a2, b1, b2, b3
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.	1	2	a2, b1, b2, b3, c1, c2
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.	1	2	a2, b1, b2, b3, c1, c2
7	**Design of discrete-time**	• Introduction to conventional design methods,	1	2	a2, b1, b2, b3,

	control systems by the conventional methods	• the root locus method, • design based the root locus method, • example problems and solutions			c1, c2
8	Mid-Term Theoretical Exam	• previous topics	1	2	a1, a2, b1, b2, b3 -
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.	1	2	a2, b1, b2, b3, c1, c2
10	Design of discrete-time control systems by the conventional methods	• Analytical design methods,, • dead beat response design methods, • example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2
11	State Space Analysis	• state space representation of discrete-time control systems, • solving the discrete-time state space equations, • design example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2
12	Pole placement and observer design (modern design methods	• Controllability, observability, • useful transformations in state space analysis, • design example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2, d1
13	Pole placement	• Pole placement design method,	1	2	a2, b1,

	and observer design (modern design methods)	• example problems and solutions.			b2, b3, c1, c2, d1
14	Pole placement and observer design (modern design methods)	• observer design method, • example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2, d1
15	Pole placement and observer design (modern design methods)	• Servo-controller design • Method example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2, d1
16	Final Theoretical Exam	All topics	1	2	a1, a2, b1, b2, b3, c1, c2
Number of Weeks /and Units Per Semester			16	32	

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	Introduction of digital control systems with matlab software	1	2	a1, a2, b1, b2, b3, c1, c2, d1
2	Discrete-time control systems simulation and Simulink.	1	2	
3	Discrete-time control systems simulation and Simulink.	1	2	
4	Time-domain digital controller emulation.	1	2	
5	Frequency-domain digital controller emulation.	1	2	

6	Sampling, aliasing, zero-order hold (simulink).	1	2	
7	Mid-Term Practical Exam (if any)	1	2	
8	Discrete-time plant modeling.	1	2	
9	Root-locus, frequency response design methods for digital controllers.	1	2	
10	Numerical optimal PID digital controller design in matlab program.	1	2	
11	State-space digital controllers design in matlab program..	1	2	
12	State-space digital controllers design in matlab program.	1	2	
13	Introduction to arduino IDE.	1	2	
14	Implementation the digital controller with microcontroller by using the mikroc and proteus simulation software.	1	2	
15	Final Practical Exam	1	2	
Number of Weeks /and Units Per Semester		15	30	

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Tutorials,
- Videos demonstrations,
- Presentation/seminar,
- Interactive class discussions,
- Case studies,
- Exercises and home works,
- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Workshops practices,

VI. Assessment Methods of the Course:

– Written tests (mid and final terms Exam and quizzes(.

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

- Class discussion.
- Presentation

VII. Assignments:

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
1	Problems, and advance problems, and computer problems of the Chapter 2	2	6	a1, a2
2	Problems, and advance problems, and computer problems of the Chapter 3	3	6	a1, a2
3	Problems, and advance problems, and computer problems of the Chapter 4	5	6	a1, a2, b1, b2, b3
4	Problems, and advance problems, and computer problems of the Chapter 5	9	6	a1, a2, b1, b2, b3
5	Problems, and advance problems, and computer problems of the Chapter 6	10	6	a1, a2, b1, b2, b3, c1, c2
Total			30	

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignments	15	30	15%	a1,a2,b1,b2,c1,c2

2	Quiz 1	6	10	15%	a1, a2, b1, b2, b3, c1, c2
3	Midterm Exam	8	30	15%	a1, a2, b1, b2, b3
4	Midterm Theoretical Exam	9	20	10%	a1, a2, b1, b2, b3
5	Quiz 2	12	10	5%	a1, a2, b1, b2, b3, c1, c2
6	Final Practical Exam	15	30	15%	a1,a2,b1,b2,c1,c2
7	Final Theoretical Exam	16	70	35%	a1,a2,b1,b2,c1,c2,d1
Total			200	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two)

1- Katsuhiko Ogata, 2010, Discrete-time control systems, 2nd Edition, Prentice Hall.

2- Dogan Ibrahim, 2006, microcontroller based applied a digital controller, 1st Edition, john wiley & sons Inc.

2- Essential References:

1- M. Sam Fadali, 2009, Digital control systems analysis and design, 1st Edition, Elsevier Inc.

2- FARIDGOLNARAGHI, BENJAMINC.KUO, 2010, Automatic Control Systems, ninth Edition, John Wiley & Sons, Inc..

3- Electronic Materials and Web Sites etc.:

Websites:

1- National Instruments

https://learn.ni.com/teach/resources/1221/digital-control

2- The National Program on Technology Enhanced Learning (NPTEL), Automatic Control

https://nptel.ac.in/courses/112/107/112107240/

Journals:

3- IEEE Transactions on control systems technology: Peer reviewed academic journal..

https://www.ieeexplore.ieee.org/xpl

4- International Journal of control, automation and systems: The leading peer reviewed

academic journal

https://www.springer.com/Journal

Other Web Sources:

5- 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/

6- Purdue University | Purdue Online Learning, College of Engineering, Digital Control

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

https://engineering.purdue.edu/ProEd/courses/digital-control

X. Course Policies: (Based on the Uniform Students' By law (2007) تترك كما هي	
1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardiness:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects:** In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating:** For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies:** Mobile phones are not allowed to use during a class lecture. It must be closed; otherwise the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be

	given directly to students using soft or hard copy.

Second Part of Course Specification

Faculty of Medical Technology

Department of Biomedical Engineering Technology

Course Specification of

Digital control System

Course No. 07.02.733

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

Analog control System

Course No. 07.02.729

I. Information about Faculty Member Responsible for the Course:							
Name of Faculty Member:	Dr. Ammar Ali Ali Abdu						
Location& Telephone No.:	Sanaa - 775207752						
E-mail:	dr.ammar.ali2018@gmail.com	SAT	SUN	MON	TUE	WED	THU
Office Hours							

2020/2021

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

I. Course Identification and General Information:

	Course Title:	Digital control System			
2	Course Code & Number:	Course No. 07.02.733			
3	Credit Hours:	Credit Hours	Theory Hours		Lab. Hours
			Lecture	Exercise	
		3	2	--	1
4	Study Level/ Semester at which this Course is offered:	3 Level / 2 Semester			
5	Pre –Requisite (if any):	Math 3, Computer principles and programming,			
6	Co –Requisite (if any):	N/A			
7	Program (s) in which the Course is Offered:	Bachelor in Biomedical Engineering Technology			
8	Language of Teaching the Course:	English			
9	Study System:	Regular (semester)			
10	Mode of Delivery:				
11	Location of Teaching the Course:	University Campus			
12	Prepared by:	Dr. Ammar Ali Ali			
13	Date of Approval:				

II. Course Description:

The Digital Control Systems course aims to give the student knowledge of the basic concepts and Theories of modeling, development, analysis, design and implement of modern and digital control systems. This course includes the basic principles of digital control systems, quantization and quantization errors, data acquisitions, Z-transform and its applications to solve difference equations, Z plane analysis for discrete time control systems, impulse sampling, pulse transfer function, PID digital controllers realization and implementation, mapping between continuous –time control systems and discrete-time control systems, stability analysis, transient and steady state response, conventional and modern design methods of digital control systems, root-locus and bode plot design methods, analytical design methods, state space representation, controllability, observability, and servo-controllers. The practical part allows students to practice different digital control approaches studied in theoretical classes.

III. Course Intended Learning Outcomes (CILOs) :(مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:	
a1	Understand the concepts, theories, and mathematical modeling of Digital systems in pulse transfer function model and state variable model.
a2	Explain how different analysis techniques are used to determine the specifications of digital control systems, and common design methods for design a digital controllers.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Apply common conventional and modern engineering methods to model, analyze, and organize the digital biomedical systems.
b2	Analysis, and evaluate the biomedical engineering systems using the modern control engineering tools, then select a suitable digital controller for biomedical systems.
b3	Design the analog controllers, and others components of the medical devices by using the control system design methods.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	

c1	characteristics of different types of plant and process, and applying the knowledge to design, and implement a digital control systems
c2	Conduct appropriate experimentation related to analog control systems, and Locate different type of analog controllers used in real medical equipment.
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Lead, and work productively as an individual and as a member of a team / multi-disciplinary team

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	**Introduction to discrete- time control systems**	• Introduction of digital control systems, • types of digital control systems, quantization methods, • data acquisition.	1	2	a1, a2
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.	1	2	a1, a2
3	**The Z-plane analysis of discrete-time control systems**	• Impulse sampling and data holding, • components of digital control systems, • pulse transfer function,	1	2	a1, a2, b1, b2, b3

		• reduction block diagram in digital control systems, • example problems and solutions.			
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.	1	2	a1, a2, b1, b2, b3
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.	1	2	a2, b1, b2, b3, c1, c2
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.	1	2	a2, b1, b2, b3, c1, c2
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	1	2	a2, b1, b2, b3, c1, c2

8	Mid-Term Theoretical Exam	• previous topics	1	2	a1, a2, b1, b2, b3 -
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.	1	2	a2, b1, b2, b3, c1, c2
10	Design of discrete-time control systems by the conventional methods	• Analytical design methods,, • dead beat response design methods, • example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2
11	State Space Analysis	• state space representation of discrete-time control systems, • solving the discrete-time state space equations, • design example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2
12	Pole placement and observer design (modern design methods	• Controllability, observability, • useful transformations in state space analysis, • design example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2, d1
13	Pole placement and observer design (modern design methods)	• Pole placement design method, • example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2, d1
14	Pole placement	• observer design method,	1	2	a2, b1,

	and observer design (modern design methods)	• example problems and solutions.			b2, b3, c1, c2, d1
15	Pole placement and observer design (modern design methods)	• Servo-controller design • Method example problems and solutions.	1	2	a2, b1, b2, b3, c1, c2, d1
16	Final Theoretical Exam	All topics	1	2	a1, a2, b1, b2, b3, c1, c2
Number of Weeks /and Units Per Semester			16	32	

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	Introduction of digital control systems with matlab software	1	2	a1, a2, b1, b2, b3, c1, c2, d1
2	Discrete-time control systems simulation and Simulink.	1	2	
3	Discrete-time control systems simulation and Simulink.	1	2	
4	Time-domain digital controller emulation.	1	2	
5	Frequency-domain digital controller emulation.	1	2	
6	Sampling, aliasing, zero-order hold (simulink).	1	2	
7	Mid-Term Practical Exam (if any)	1	2	
8	Discrete-time plant modeling.	1	2	
9	Root-locus, frequency response design methods for digital controllers.	1	2	

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

10	Numerical optimal PID digital controller design in matlab program.	1	2	
11	State-space digital controllers design in matlab program..	1	2	
12	State-space digital controllers design in matlab program.	1	2	
13	Introduction to arduino IDE.	1	2	
14	Implementation the digital controller with microcontroller by using the mikroc and proteus simulation software.	1	2	
15	Final Practical Exam	1	2	
Number of Weeks /and Units Per Semester		**15**	**30**	

V. Teaching Strategies of the Course:

- Lectures
- Discussion
- Assignment
- Self-learning
- Lab experiments
- Training at computer labs(Simulation)
- Small group discussion

VI. Assessment Methods of the Course:

- Written tests (mid and final terms Exam and quizzes(.
- Class discussion.
- Presentation

VII. Assignments:

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
1	Problems, and advance problems, and computer problems of the Chapter 2	2	6	a1, a2
2	Problems, and advance problems, and computer problems of the Chapter 3	3	6	a1, a2
3	Problems, and advance problems, and computer problems of the Chapter 4	5	6	a1, a2, b1, b2, b3
4	Problems, and advance problems, and computer problems of the Chapter 5	9	6	a1, a2, b1, b2, b3
5	Problems, and advance problems, and computer problems of the Chapter 6	10	6	a1, a2, b1, b2, b3, c1, c2
Total			30	

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignments	15	30	15%	a1,a2,b1,b2,c1,c2
2	Quiz 1	6	10	15%	a1, a2, b1, b2, b3, c1, c2

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Ammar Ali Ali Abdu	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-Shamahi	Dr. Abdulrahman Obaid

3	Midterm Exam	8	30	15%	a1, a2, b1, b2, b3
4	Midterm Theoretical Exam	9	20	10%	a1, a2, b1, b2, b3
5	Quiz 2	12	10	5%	a1, a2, b1, b2, b3, c1, c2
6	Final Practical Exam	15	30	15%	a1,a2,b1,b2,c1,c2
7	Final Theoretical Exam	16	70	35%	a1,a2,b1,b2,c1,c2,d1
Total			200	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two)

1- Katsuhiko Ogata, 2010, Discrete-time control systems, 2nd Edition, Prentice Hall.

2- Dogan Ibrahim, 2006, microcontroller based applied a digital controller, 1st Edition, john wiley & sons Inc.

2- Essential References:

1- M. Sam Fadali, 2009, Digital control systems analysis and design, 1st Edition, Elsevier Inc.

2- FARIDGOLNARAGHI, BENJAMINC.KUO, 2010, Automatic Control Systems, ninth Edition, John Wiley & Sons, Inc..

3- Electronic Materials and Web Sites etc.:

Websites:

1- National Instruments

https://learn.ni.com/teach/resources/1221/digital-control

2- The National Program on Technology Enhanced Learning (NPTEL), Automatic Control

https://nptel.ac.in/courses/112/107/112107240/

Journals:

3- IEEE Transactions on control systems technology: Peer reviewed academic journal..

https://www.ieeexplore.ieee.org/xpl

4- International Journal of control, automation and systems: The leading peer reviewed

academic journal

https://www.springer.com/Journal

Other Web Sources:

5- 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/

6- Purdue University | Purdue Online Learning, College of Engineering, Digital Control

https://engineering.purdue.edu/ProEd/courses/digital-control

X. Course Policies: (Based on the Uniform Students' By law (2007) تترك كما هي

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.

2	**Tardiness:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects:** In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating:** For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies:** Mobile phones are not allowed to use during a class lecture. It must be closed; otherwise the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.