# 43. Course Specification of Digital Control Systems

## I. Course Identification and General Information:

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Digital Control Systems | | | | |
| **2.** | Course Code & Number: | CCE332 | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | - | 2 | - | 3 |
| **4.** | Study level/ semester at which this course is offered: | Fourth Year/ Second Semester | | | | |
| **5.** | Pre –requisite (if any): | Analog Control System (CCE331) | | | | |
| **6.** | Co –requisite (if any): | None | | | | |
| **7.** | Program (s) in which the course is offered: | Computer Engineering and Control Program | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | Location of teaching the course: | Faculty of Engineering | | | | |
| **10.** | Prepared By: | Asst. Prof. Dr. Mohammed Abdullah Al-olofi | | | | |
| **11.** | Date of Approval | | | | | |

## II. Course Description:

The course aims to provide students with advanced mathematical methods and concepts required in the design of modern control systems to meet the increasing demands in industrial and control applications. Course topics include the basic principles of Digital control systems, Quantization and quantization errors, data acquisitions, Z-transform method, application of Z-transform for solving of the difference equations & Z- plane analysis for discrete time control systems, 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, controllability, observability and the observer design & servo-controller. Throughout Lab and computer-based works students will

| |
|---|
| develop the problem-solving skills related to the field of modern control systems for industrial and control issues and applications. |

| III. Course Intended learning outcomes (CILOs) of the course | | Referenced PILOs |
|---|---|---|
| **a1** | Show 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 computer engineering and control. | A2 |
| **b1** | Evaluate the digital control systems using the modern digital control engineering tools. | B1 |
| **b2** | Analyze the digital systems and the others components of the digital control products by using the digital control system design methods. | B3 |
| **c1** | Apply the digital control system hardware & software-based information technology tools to measure, evaluate and solve the computer and control systems performance and problems. | C1 |
| **c2** | Design the digital controllers and the others components of the digital control systems by using the digital control system design methods. | C2 |
| **d1** | Work productively as an individual and as a member of a team / multi-disciplinary team. | D1 |
| **d2** | Prepare and present effective technical reports and presentations. | D4 |

| **(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** Show the concepts and the mathematical modeling of digital feedback control systems in pulse transfer function model and state variable model. | ▪ Active Lectures.<br>▪ Computer-based Laboratory work, | ▪ Written Assessment.<br>▪ Homework,<br>▪ Exam |
| **a2** Explain basic principles, components of digital control systems, and application of digital control systems in computer engineering and control. | ▪ Active Lectures.<br>▪ Computer-based Laboratory work, | ▪ Written Assessment.<br>▪ Simulation.<br>▪ exam |

| **(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **b1** Evaluate the digital control systems using the modern digital control engineering tools. | ▪ Active Lectures,<br>▪ Computer-based Laboratory work,<br>▪ Design Work and Project.<br>▪ Case Studies | ▪ Written Assessment.<br>▪ Lab & Project Reports.<br>▪ Exam |
| **b2** Analyze the digital systems and the others components of the digital control products by using the digital control system design methods. | ▪ Active Lectures,<br>▪ Hands on Lab Works,<br>▪ Computer-based Laboratory work,<br>▪ Design Work and Project.<br>▪ Case Studies. | ▪ Written Assessment.<br>▪ Lab & Project Reports<br>▪ Exam |

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| © 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 hardware & software-based information technology tools to measure, evaluate and solve the computer and control systems performance and problems. | ▪ Computer-based Laboratory work,<br>▪ Design Work and Project.<br>▪ Self-Learning Study,<br>▪ Homework & Assignments,<br>▪ Case Studies. | ▪ Written Assessment.<br>▪ Lab & Project Reports,<br>▪ Presentations,<br>▪ Exam |
| **c2** Design the digital controllers and the others components of the digital control systems by using the digital control system design methods. | ▪ Active Lectures.<br>▪ Hands on Lab Works,<br>▪ Computer-based Laboratory work,<br>▪ Design Work and Project.<br>▪ Case Studies. | ▪ Written Assessment.<br>▪ Lab & Project Reports,<br>▪ Exam |

| (D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies: | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **d1** Work productively as an individual and as a member of a team / multi-disciplinary team. | ▪ Group Learning,<br>▪ Homework & Assignments,<br>▪ Projects | ▪ Lab & Project Reports.<br>▪ Presentations. |
| **d2** Prepare and present effective technical reports and presentations. | ▪ Hands on Laboratory Work,<br>▪ Projects,<br>▪ Homework & Assignments, | ▪ Lab & Project Reports.<br>▪ Presentations. |

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## 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, c2 | 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, c2 | 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, c2 | PID digital controllers, realization and implementation of digital controllers, microcontroller implementation to digital controllers, select the sampling interval, example problems and solutions. | **1** | **2** |

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|---|---|---|---|---|---|
| **5.** | Design of discrete-time control systems by the conventional methods | a1, a2, b1, b2, c2 | 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, b2, c2 | 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, c2 | Introduction to conventional design methods, the root locus method, design based the root locus method, example problems and solutions. | **1** | **2** |
| **8.** | Design of discrete-time control systems by the conventional methods | a1, a2, b1, b2, c2 | Frequency response methods, bode plot, design based on the Frequency response methods, example problems and solutions. | **1** | **2** |
| **9.** | Design of discrete-time control systems by the conventional methods | a1, a2, b1, b2, c2 | Analytical design methods,, dead beat response design methods, example problems and solutions. | **1** | **2** |
| **10.** | State Space Analysis | a1, a2, b1, b2, c2 | state space representation of discrete-time control systems, solving the discrete-time state space equations, design example problems and solutions. | **1** | **2** |
| **11.** | Pole placement and observer | a1, a2, b1, b2, c2 | Controllability, observability, useful transformations in state space | **1** | **2** |

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|---|---|---|---|---|---|
| | design (modern design methods) | | analysis, design example problems and solutions. | | |
| **12.** | Pole placement and observer design (modern design methods) | a1, a2, b1, b2, c2 | Pole placement design method, example problems and solutions.. | **1** | **2** |
| **13.** | Pole placement and observer design (modern design methods) | a1, a2, b1, b2, c2 | observer design method, example problems and solutions.. | **1** | **2** |
| **14.** | Pole placement and observer design (modern design methods) | a1, a2, b1, b2, c2 | Servo-controller design method, example problems and solutions.. | **1** | **2** |
| **Number of Weeks /and Units Per Semester** | | | | **14** | **28** |

**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, a2, d1 |
| **2.** | Discrete-time control systems simulation and Simulink. | 1 | 2 | a1, b1, b2, c2, d1, d2 |
| **3.** | Time-domain digital controller emulation. | 1 | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **4.** | Frequency-domain digital controller emulation. | 1 | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **5.** | Sampling, aliasing, zero-order hold (simulink). | 1 | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **6.** | Discrete-time plant modeling. | 1 | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **7.** | Midterm Practical Exam | 1 | 2 | a1, a2, b1, b2,, c1, c2, d1, d2 |
| **8.** | Root-locus, frequency response design methods for digital controllers. | 1 | 2 | a1, a2, b1, b2,c1, c2, d1, d2 |

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|---|---|---|---|---|
| **9.** | Numerical optimal PID digital controller design in matlab program. | 1 | 2 | a1, a2, b1, b2,c1, c2, d1, d2 |
| **10.** | State-space digital controllers design in matlab program. | 1 | 2 | a1, a2, b1, b2,c1, c2, d1, d2 |
| **11.** | Introduction to arduino IDE. | 1 | 2 | a1, a2, b1, b2,c1, c2, d1, d2 |
| **12.** | Implementation the digital controller with microcontroller by using the mikroc and proteus simulation software. | 1 | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **13.** | Review | 1 | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **14.** | Project Presentations: - students works in groups of 2 or 3 peoples for solving some practical problems related to computer and control engineering. | 1 (Starting from week No. 3) | 2 | a1, a2, b1, b2, c1, c2, d1, d2 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** | |

## V. Teaching strategies of the course:

In general, teaching and learning in undergraduate engineering education programs should use a variety of teaching methods, such as:

- Active Lectures (supported with discussions).
- Hands on Lab Works,
- Computer-based Lab Works,
- Design Work and Project,
- Homework & Assignments,
- Case Studies
- The Use of Communication and Information Technology.
- Group Learning.

## VI. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | Problems, and advance problems, and computer problems of the Chapter 2 | a1, a2, b1, c1 | 2nd | 1 |

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| **2.** | Problems, and advance problems, and computer problems of the Chapter 3 | a1, a2, b1, c1, c2, d1, d2 | 5th | 1 |
| **3.** | Problems, and advance problems, and computer problems of the Chapter 4 | a1, a2, b1, b2, c1, c2, c3, d1, d2 | 8th | 2 |
| **4.** | Problems, and advance problems, and computer problems of the Chapter 5 | a1, a2, b1, b2, c1, c2, c3, d1, d2 | 12th | 2 |
| **5.** | Problems, and advance problems, and computer problems of the Chapter 6 | a1, a2, b1, b2, c1, c2, c3, d1, d2 | 14th | 2 |
| **6.** | Lab Reports | a1, a2, b1, b2, c1, c2, c3, d1 | 3rd to 12th | 7 |
| | **Total** | | | **15** |

## VII. 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 & Reports | 3rd to 14th | 15 | 10% | a1, a2, b1, b2, c1,c2, d1, d2 |
| **2.** | Quizzes | 5th, 10th & 14th | 10 | 6.67% | a1, a2, b1, b2, c2, d1 |
| **3.** | Midterm Exam (Theory) | 8th | 20 | 13.33% | a1, a2, b1, b2, c2 |
| **4.** | Final Lab. Exam (including Course Project Evaluation) | 14th & 15th | 30 | 20% | b1, b2, c1,c2, d1, d2 |
| **5.** | Final Exam (Theory) | 16th | 75 | 50% | a1, a2, b1, b2, c2, |
| | **Total** | | **150** | **100%** | |

## VIII. 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, Discrete-time control systems, 2nd Edition, Prentice Hall,2010

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| | 2. Dogan Ibrahim, microcontroller based applied a digital controller, 1st Edition, john wiley & sons Inc., 2006. |
| **2- Essential References.** | |
| | 1. M. Sam Fadali, Digital control systems analysis and design, 1st Edition, Elsevier Inc,2009 |
| **3- Electronic Materials and Web Sites *etc*.** | |
| | 1. http://www.sciencedirect.com/<br>2. http://dl.acm.org/dl.cfm<br>3. http://ieeexplore.ieee.org/Xplore/guesthome.jsp<br>4. http://www.emeraldinsight.com<br>5. http://www.scopus.com/home.url<br>6. http://link.springer.com/ |

| **IX. Course Policies:** | |
|---|---|
| **1.** | **Class Attendance:**<br>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 an approved statement from university<br>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.** | **Tardy:**<br>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:**<br>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:**<br>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. |

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| **5.** | **Cheating**:<br>For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty. |
| **6.** | **Plagiarism**:<br>Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved 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:**<br>- 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.<br>- Mobile phones are not allowed in class during the examination.<br>- Lecture notes and assignments might be given directly to students using soft or hard copy. |

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| **Reviewed By** | **Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat**<br>**President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi**<br>**Name of Reviewer from the Department: Assoc. Prof. Dr. Farouk Al-Fuhaidy** |
| | **Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa**<br>**Assoc. Prof. Dr. Ahmed Mujahed**<br>**Asst. Prof. Dr. Munasar Alsubri** |

# 43. Template for Course Plan of Digital Control Systems

## I. Information about Faculty Member Responsible for the Course:

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

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## II. Course Identification and General Information:

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Digital Control Systems | | | | |
| **2.** | Course Number & Code: | CCE332 | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | - | 2 | - | 4 |
| **4.** | Study level/year at which this course is offered: | Fourth Year/ Second Semester | | | | |
| **5.** | Pre –requisite (if any): | Analog Control System (CCE331) | | | | |
| **6.** | Co –requisite (if any): | None | | | | |
| **7.** | Program (s) in which the course is offered | Computer Engineering and Control Program | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | System of Study: | Semester | | | | |
| **10.** | Mode of delivery: | Collective and individual learning | | | | |
| **11.** | Location of teaching the course: | Faculty of Engineering | | | | |

## III. Course Description:

The course aims to provide students with advanced mathematical methods and concepts required in the design of modern control systems to meet the incresing demands in industrial and control applications. Course topics include the basic principles of Digital control systems, Quantization and quantization errors, data acquisitions, Z-transform method, application of Z-transform for solving of the difference equations & Z- plane analysis for discrete time control systems, 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, controllability, observability and the observer design & servo-controller. Throughout tutorial and computer-based works students will develop the problem-solving skills related to the field of modern control systems for industrial and control issues and applications.

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## IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Show the concepts and the mathematical modeling of digital feedback control systems in pulse transfer function model and state variable model.
2. Explain basic principles, components of digital control systems, and application of digital control systems in computer engineering and control.
3. Evaluate the digital control systems using the modern digital control engineering tools.
4. Analyze the digital systems and the others components of the digital control products by using the digital control system design methods.
5. Apply the digital control system hardware & software-based information technology tools to measure, evaluate and solve the computer and control systems performance and problems.
6. Design the digital controllers and the others components of the digital control systems by using the digital control system design methods.
7. Work productively as an individual and as a member of a team / multi-disciplinary team.
8. Prepare and present effective technical reports and presentations.

## V. Course Content:

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

### A – Theoretical Aspect:

| Order | Topics List | Sub Topics List | Week Due | Contact Hours |
|---|---|---|---|---|
| **1.** | Introduction to discrete- time control systems | Introduction of digital control systems, types of digital control systems, quantization methods, data acquisition. | 1st | 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. | 2nd | 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. | 3rd | 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. | 4th | 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. | 5th | 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.. | 6th | 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. | 7th | 2 |
| **8.** | Midterm Exam | | 8th | 2 |
| **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. | 9th | 2 |
| **10.** | Design of discrete-time control systems by the conventional methods | Analytical design methods, dead beat response design methods, example problems and solutions. | 10th | 2 |
| **11.** | State Space Analysis | state space representation of discrete-time control systems, solving the | 11th | 2 |

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|---|---|---|---|---|
| | | discrete-time state space equations, design example problems and solutions. | | |
| **12.** | Pole placement and observer design (modern design methods) | Controllability, observability, useful transformations in state space analysis, design example problems and solutions. | 12th | 2 |
| **13.** | Pole placement and observer design (modern design methods) | Pole placement design method, example problems and solutions. | 13th | 2 |
| **14.** | Pole placement and observer design (modern design methods) | observer design method, example problems and solutions. | 14th | 2 |
| **15.** | Pole placement and observer design (modern design methods) | Servo-controller design method, example problems and solutions. | 15th | 2 |
| **16.** | Final Exam | | 16th | 2 |
| **Number of Weeks /and Units Per Semester** | | | **16** | **32** |

## B – Practical Aspect:

| Order | Topics List | Week Due | Contact Hours |
|---|---|---|---|
| **1.** | Introduction of digital control systems with matlab software. | 1st | 2 |
| **2.** | Discrete-time control systems simulation and Simulink. | 2nd | 2 |
| **3.** | Time-domain digital controller emulation. | 3rd | 2 |
| **4.** | Frequency-domain digital controller emulation. | 4th | 2 |
| **5.** | Sampling, aliasing, zero-order hold (simulink). | 5th | 2 |
| **6.** | Discrete-time plant modeling. | 6th | 2 |
| **7.** | Midterm Practical Exam | 7th | 2 |
| **8.** | Root-locus, frequency response design methods for digital controllers. | 8th | 2 |
| **9.** | Numerical optimal PID digital controller design in matlab program. | 9th | 2 |

| | | | |
|---|---|---|---|
| **10.** | State-space digital controllers design in matlab program. | 10th | 2 |
| **11.** | Introduction to arduino IDE. | 11th | 2 |
| **12.** | Implementation the digital controller with microcontroller by using the mikroc and proteus simulation software. | 12th | 2 |
| **13.** | Review | 13th | 2 |
| **14.** | Project Presentations | 14th | 2 |
| **15.** | Final Practical Exam | 15th | 2 |
| **Number of Weeks /and Units Per Semester** | | **15th** | **28** |

## VI. Teaching strategies of the course:

In general, teaching and learning in undergraduate engineering education programs should use a variety of teaching methods, such as:

- Active Lectures (supported with discussions).
- Hands-on Laboratory Work,
- Computer-based Lab Works,
- Homework & Assignments,
- Design Work & Projects,
- Independent Learning and Work.
- Group Learning and Problem-Based Learning.
- The Use of Communication and Information Technology.
- Case Studies.

## VII. Assignments:

| No | Assignments | Week Due | Mark |
|---|---|---|---|
| **1.** | Problems, and advance problems, and computer problems of the Chapter 2 | 2nd | 1 |
| **2.** | Problems, and advance problems, and computer problems of the Chapter 3 | 5th | 1 |
| **3.** | Problems, and advance problems, and computer problems of the Chapter 4 | 8th | 2 |

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|---|---|---|---|
| **4.** | Problems, and advance problems, and computer problems of the Chapter 5 | 12th | 2 |
| **5.** | Problems, and advance problems, and computer problems of the Chapter 6 | 14th | 2 |
| **6.** | Lab Reports | 3rd to 12th | 7 |
| | **Total** | | **15** |

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

| Assessment | Type of Assessment Tasks | Week Due | Mark | Proportion of Final Assessment |
|---|---|---|---|---|
| **1.** | Assignments & Reports | 3rd to 14th | 15 | 10% |
| **2.** | Quizzes | 5th, 10th & 14th | 10 | 6.67% |
| **3.** | Midterm Exam (Theory) | 8th | 20 | 13.33% |
| **4.** | Final Lab. Exam (including Course Project Evaluation) | 14th & 15th | 30 | 20% |
| **5.** | Final Exam (Theory) | 16th | 75 | 50% |
| | **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, Discrete-time control systems, 2nd Edition, Prentice Hall,2010
2. Dogan Ibrahim, microcontroller based applied a digital controller, 1st Edition, john wiley & sons Inc., 2006

**2- Essential References.**

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

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

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

1. http://www.sciencedirect.com/
2. http://dl.acm.org/dl.cfm
3. http://ieeexplore.ieee.org/Xplore/guesthome.jsp
4. http://www.emeraldinsight.com
5. http://www.scopus.com/home.url
6. http://link.springer.com/

## X. Course Policies:

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|---|---|
| **1.** | **Class Attendance:**<br>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 an approved statement from university<br>Clinic. If the absent is more than 25% of a course total contact hour, student will be required to retake the entire course again. |
| **2.** | **Tardy:**<br>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:**<br>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:**<br>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**:<br>For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty. |
| **6.** | **Plagiarism**:<br>Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty |

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| | should be confirmed from the Student Council Affair of the university or according to the university roles. |
| **7.** | **Other policies:**<br>- 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.<br>- Mobile phones are not allowed in class during the examination.<br>- Lecture notes and assignments might be given directly to students using soft or hard copy. |

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