University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Course Specification of Biomedical Signals Processing

Course Code (BE225)

<table>
<tr><th colspan="7">I. Course Identification and General Information:</th></tr>
<tr><td>1</td><td>Course Title:</td><td colspan="5">Biomedical Signals Processing</td></tr>
<tr><td>2</td><td>Course Code & Number:</td><td colspan="5">BE225</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Credit hours:</td><td colspan="4">C.H</td><td rowspan="2">TOTAL</td></tr>
<tr><td>Th.</td><td>Seminar</td><td>Pr</td><td>Tr.</td></tr>
<tr><td>2</td><td>--</td><td>2</td><td>--</td><td>3</td></tr>
<tr><td>4</td><td>Study level/ semester at which this course is offered:</td><td colspan="5">3rd Level / 2nd Semester</td></tr>
<tr><td>5</td><td>Pre –requisite (if any):</td><td colspan="5">Probability and Statistics for Engineers (BR231), Biomedical Sensors and Measurements (BE224).</td></tr>
<tr><td>6</td><td>Co –requisite (if any):</td><td colspan="5">Analog Control Systems (BE251).</td></tr>
<tr><td>7</td><td>Program (s) in which the course is offered:</td><td colspan="5">Biomedical Engineering Program</td></tr>
<tr><td>8</td><td>Language of teaching the course:</td><td colspan="5">English</td></tr>
<tr><td>9</td><td>Location of Teaching the Course:</td><td colspan="5">Faculty of Engineering</td></tr>
<tr><td>10</td><td>Prepared by:</td><td colspan="5">Dr. Mohammed Al-olofi</td></tr>
<tr><td>11</td><td>Reviewed by:</td><td colspan="5">Dr. Waleed Al-Talbi</td></tr>
<tr><td>12</td><td>Date of Approval:</td><td colspan="5"></td></tr>
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II. Course Description:

The biomedical signals processing course aims to give the student knowledge of the Signal representation: Continuous-time and Discrete-time signals, overview of analog and discrete-time signals properties, Fourier analysis, and time-frequency analysis. Then study discrete-time filter, the Z-transform, and sampling. The convolution theorem for the Fourier and z-transform will be presented. Next, Various estimation, detection and filtering methods are developed and demonstrated on biomedical signals and application on EEG-ECG signals are introduced in detail. Throughout Computer-based lab graduates will develop their programming skills related to the development of algorithms for biomedical signal processing.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		Referenced PILOs (Only write code number of referenced Program Intended learning outcomes)
Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
a1	Demonstrate understanding the basic principles, and theories in biomedical signal processing engineering fundamentals.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Describe the connections between the variety of fields and specialties in biomedical signal processing engineering and the wide range of medical needs, techniques, working principles and instruments associates with signal processing engineering.	A2 Clarify the design principles and techniques and the engineering materials characteristics and how these are relevant to the developments and technologies in a biomedical systems context.
a3	Illustrate understanding of biomedical signal processing engineering ethics, side by side understanding of the fundamentals of healthcare technology, signal processing	A3 Recognize and explain the need for a high level of management, professional and ethical behavior, responsibility, quality assurance systems, codes of practice, standards, health

	instrumentation, tissue engineering, biomaterials, biomechanics and clinical engineering.	and safety requirements, and environmental impacts in biomedical systems.
B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
b1	Design the biomedical signals processing systems which are used in medical equipment to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.	B3 Design the biomedical systems or processes within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
b2	Categorize the biomedical signals processing systems according to their specifications and features.	B5 Distinguish the main characteristics of biomedical systems, apply diagnostic skills and technical knowledge and perform failure analysis to these systems.
C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
c1	Apply mathematical, simulation models, and IT software packages to design, and implement the biomedical signals processing systems effectively.	C2 Use a wide range of analytical tools, techniques, IT, modern engineering tools, software packages and develop required computer programs to solve, modeling and analyzing Biomedical Engineering problems.
c2	Evaluate the performance of medical equipment based on the biomedical signals processing systems used in them.	C4 Use rules and regulations of industrial safety as well as safe and diagnose systems at work, evaluate performance and observe the appropriate steps to manage risks concerning biomedical systems.

D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
d1	Function effectively in different work environments as an individual, and as a member or leader in multi-disciplinary teams.	D1 Lead and motivate individuals, show capability to work in stressful environments and within constraints, collaborate effectively within multidisciplinary team.

(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 Demonstrate understanding the basic principles, and theories in biomedical signal processing engineering fundamentals.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training,	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Presentations.

	• Mini/major project.	
a2 Describe the connections between the variety of fields and specialties in biomedical signal processing engineering and the wide range of medical needs, techniques, working principles and instruments associates with signal processing engineering.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training, • Mini/major project.	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Presentations.
a3 Illustrate understanding of biomedical signal processing engineering ethics, side by side understanding of the fundamentals of healthcare technology, signal processing instrumentation, tissue engineering, biomaterials, biomechanics and clinical	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment,

engineering.	session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training, • Mini/major project.	• Presentations.

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

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1 Design the biomedical signals processing systems which are used in medical equipment to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning,	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Presentations.

	• Team work (cooperative learning), • Field visits/training, • Mini/major project.	
b2 Categorize the biomedical signals processing systems according to their specifications and features.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training, • Mini/major project.	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Presentations.

(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 mathematical, simulation models, and IT software packages to design, and	• Interactive lectures & examples, • Tutorials,	• Written tests (mid and final terms and quizzes),

implement the biomedical signals processing systems effectively.	• Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training, • Mini/major project.	• Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • sPresentations.
c2 Evaluate the performance of medical equipment based on the biomedical signals processing systems used in them.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices,	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Presentations.

	• Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training, • Mini/major project.	

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1 Function effectively in different work environments as an individual, and as a member or leader in multi-disciplinary teams.	• Interactive lectures & examples, • Tutorials, • Videos demonstrations, • Presentation/seminar, • Interactive class discussions, • Case studies, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Workshops practices, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Field visits/training, • Mini/major project.	• Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Presentations.

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	**Introduction**	a1, a2, a3	– Overview of digital signal processing (DSP). – Overview of biomedical applications of DSP.	1	2
2	**Discrete-Time Signals and Systems**	a1, a2, a3	– Sampling and discrete form of signals. – Discrete systems – Convolution – Difference equations	1	2
3	**Discrete-Time Fourier Analysis**	a1, a2, a3, b1,b2	– Review of Continuous Fourier transform (CFT) – Discrete-time Fourier transform (DTFT). – Frequency domain analysis of linear time invariant systems – Analysis of sampling and reconstruction of analog signals.	1	2
4	**The z-Transform**	a1, a2, a3, b1,b2	– Definition and of forward z-transform	1	2
5	**The z-Transform**	a1, a2, a3, b1,b2	– Inversion of z-transform – Solution of difference equations	1	2
6	**Sampling**	a1, a2, a3, b1,b2, c1, c2	– Representation of sampling in the frequency domain	1	2

			– Recovery of continuous domain signals from discrete samples – Discrete-time processing of continuous signals – Quantization errors and other sources of error.		
7	**The Discrete Fourier Transform (DFT)**	a1, a2, a3, b1,b2, c1, c2	– The discrete Fourier series analysis – Sampling and reconstruction in the z-domain – The discrete Fourier transform (DFT) – Linear and circular convolution using DFT – The Fast Fourier Transform (FFT)	1	2
8	**Mid-Term Theoretical Exam**	a1, a2, a3, b1,b2, c1, c2	- All Previous Topics	1	2
9	**Introduction to Digital Filters**	a1, a2, a3, b1,b2, c1, c2	– FIR vs. IIR filters – Implementation/realization structures	1	2
10	**FIR Filter Design**	a1, a2, a3, b1,b2, c1, c2	– Properties of linear phase FIR filters – Window design techniques – Frequency sampling design techniques – Optimal equi-ripple design technique	1	2
11	**IIR Filter Design**	a1, a2, a3, b1,b2, c1, c2	– Characteristics of classical analog filters	1	2

			– Design using transformation methods		
12	**Report & Presentation**	a1, a2, a3, b1,b2, c1, c2, d1	– 3 to 4 students make report and present the seminar on the one biomedical signal processing.	1	2
13	**Application in medical signals.**	a1, a2, a3, b1,b2, c1, c2, d1	– ECG Artifact Removal	1	2
14	**Application in medical signals.**	a1, a2, a3, b1,b2, c1, c2	– ECG Arrhythmia detection	1	2
15	**Application in medical signals.**	a1, a2, a3, b1,b2, c1, c2	– Brain-Computer Interface Signal Processing	1	2
16	**Final Theoretical Exam**	a1, a2, a3, b1,b2, c1, c2	- All Topics	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect: (if any)

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	- Introduction to Signal Processing and Matlab software	1	2	a1, a2, a3
2	- Discrete-Time Signals and Operations by using Matlab software	1	2	a1, a2, a3, b1,b2, c1, c2
3	- Continuous-Time Signals and Operations by using Matlab software	1	2	a1, a2, a3, b1,b2, c1, c2
4	- Frequency Analysis of Discrete-Time Signals by using Matlab software	1	2	a1, a2, a3, b1,b2, c1, c2
5	- Frequency Analysis of Continuous-	1	2	a1, a2, a3, b1,b2, c1, c2

	Time Signals by using Matlab software			
6	- Sampling Theory and Practice by using Matlab software	1	2	a1, a2, a3, b1,b2, c1, c2
7	- Midterm Practical Exam	1	2	a1, a2, a3, b1,b2, c1, c2
8	- Frequency Analysis of Discrete-Time Systems by using Matlab software	1	2	a1, a2, a3, b1,b2, c1, c2
9	- Frequency Analysis of Continuous-Time Systems by using Matlab software	1	2	a1, a2, a3, b1,b2, c1, c2
10	- Applications of biomedical signals processing (ECG Artifact Removal).	1	2	a1, a2, a3, b1,b2, c1, c2
11	- Applications of biomedical signals processing (ECG Arrhythmia detection).	1	2	a1, a2, a3, b1,b2, c1, c2
12	- Applications of biomedical signals processing (Brain-Computer Interface Signal Processing).	1	2	a1, a2, a3, b1,b2, c1, c2
13	- Applications of biomedical signals processing (Brain-Computer Interface Signal Processing).	1	2	a1, a2, a3, b1,b2, c1, c2, d1
14	- Practical Project	1	2	a1, a2, a3, b1,b2, c1, c2, d1
15	- Final Practical Exam	1	2	a1, a2, a3, b1,b2, c1, c2
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,
- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Workshops practices,
- Directed self- study,
- Problem based learning,
- Team work (cooperative learning),
- Field visits/training,
- Mini/major project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Short reports,
- Lab\Project report
- Practical lab performance assessment,
- Coursework activities assessment,
- Presentations.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1				

2				
3				
4				
5				
Total				

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	**Quiz 1**	6	5	3.33%	a1, a2, a3, b2,c1, c2
2	**Midterm Practical Exam**	7	20	13.33%	a1, a2, a3, b2,c1, c2
3	**Midterm Theoretical Exam**	8	10	6.67%	a1, a2, a3, b2,c1, c2
4	**Report, Presentation, and Project**	12, 13	20	13.33%	a1, a2, a3, b2,c1, c2, d1
5	**Quiz 2**	12	5	3.33%	a1, a2, a3, b2,c1, c2
6	**Final Practical Exam**	15	30	20%	a1, a2, a3, b2,c1, c2
7	**Final Theoretical Exam**	16	60	40%	a1, a2, a3, b2,c1, c2
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- John R. Buck, Alan V. V. Oppenheim, Alan V. Oppenheim, and Ronald W. Schafer, 2021, **Discrete-Time Signal Processing**, 3rd Edition, Prentice-Hall Signal Processing Series

2- C. Sidney Burrus, James C. McClellan, et al., 1993, **Computer-Based Exercises for Signal Processing Using Matlab**, Prentice Hall.

2- Essential References.

1- ALAN OPPEHIOHN, 2015, " **Signal processing**", 3rd Ed, USA, Elsevier Inc.

2- Hykin., 2017, **"Principles of signal processing Engineering",** UK, Artech House.

3- Joseph D. Bronzino, Donald R. Peterson., 2015, "**The signal processing Engineering Handbook: .**", 4th Ed, USA, CRC Press.

3- Electronic Materials and Web Sites *etc.*

Websites:

1- The Biomedical Engineering Society (BMES) is the professional society for biomedical engineering and bioengineering. Founded in early 1968.
https://www.bmes.org/

2- BMES is a Sponsored Student Organization (SSO) comprised of a group of students who are interested in the biomedical engineering field and in networking with industry, peers, faculty, and alumni.
http://www.bmes.bme.umich.edu/

Journals:

3- *Biomedical Engineering journal* covers recent advances in the growing field of biomedical technology, instrumentation, and administration.
https://www.springer.com/journal/10527

4- Journal of Biomedical Engineering provides a forum for the publication of the latest developments in biomedical engineering, and reflects the essential multidisciplinary nature of the subject.
https://www.sciencedirect.com/journal/journal-of-biomedical-engineering

Other Web Sources:

5- Biomedical engineering forums.
https://www.ebme.co.uk/forums/

X. Course Policies:	
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	**Tardy:** 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.

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
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Template for Course Plan (Syllabus)

Biomedical Signals Processing- BE225

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<tr><td rowspan="3">3</td><td rowspan="3">Credit Hours:</td><td rowspan="2">Credit Hours</td><td colspan="2">Theory Hours</td><td rowspan="2">Lab. Hours</td></tr>
<tr><td>Lecture</td><td>Exercise</td></tr>
<tr><td>3</td><td>2</td><td>--</td><td>2</td></tr>
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II. Course Description:

The biomedical signals processing course aims to give the student knowledge of the Signal representation: Continuous-time and Discrete-time signals, overview of analog and discrete-time signals properties, Fourier analysis, and time-frequency analysis. Then study discrete-time filter, the Z-transform, and sampling. The convolution theorem for the Fourier and z-transform will be presented. Next, Various estimation, detection and filtering methods are developed and demonstrated on biomedical signals and application on EEG-ECG signals are introduced in detail. Throughout Computer-based lab graduates will develop their programming skills related to the development of algorithms for biomedical signal processing.

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	Demonstrate understanding the basic principles, and theories in biomedical signal processing engineering fundamentals.
a2	Describe the connections between the variety of fields and specialties in biomedical signal processing engineering and the wide range of medical needs, techniques, working principles and instruments associates with signal processing engineering.
a3	Illustrate understanding of biomedical signal processing engineering ethics, side by side understanding of the fundamentals of healthcare technology, signal processing instrumentation, tissue engineering, biomaterials, biomechanics and clinical engineering.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Design the biomedical signals processing systems which are used in medical equipment to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.
b2	Categorize the biomedical signals processing systems according to their specifications and features.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Apply mathematical, simulation models, and IT software packages to design, and implement the biomedical signals processing systems effectively.
c2	Evaluate the performance of medical equipment based on the biomedical signals processing

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)	
	systems used in them.
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Function effectively in different work environments as an individual, and as a member or leader in multi-disciplinary teams.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction**	– Overview of digital signal processing (DSP). – Overview of biomedical applications of DSP.	1	2
2	**Discrete-Time Signals and Systems**	– Sampling and discrete form of signals. – Discrete systems – Convolution – Difference equations	1	2
3	**Discrete-Time Fourier Analysis**	– Review of Continuous Fourier transform (CFT) – Discrete-time Fourier transform (DTFT). – Frequency domain analysis of linear time invariant systems – Analysis of sampling and reconstruction of analog signals.	1	2
4	**The z-Transform**	– Definition and of forward z-transform	1	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
5	**The z-Transform**	– Inversion of z-transform – Solution of difference equations	1	2
6	**Sampling**	– Representation of sampling in the frequency domain – Recovery of continuous domain signals from discrete samples – Discrete-time processing of continuous signals – Quantization errors and other sources of error.	1	2
7	**The Discrete Fourier Transform (DFT)**	– The discrete Fourier series analysis – Sampling and reconstruction in the z-domain – The discrete Fourier transform (DFT) – Linear and circular convolution using DFT – The Fast Fourier Transform (FFT)	1	2
8	**Mid-Term Theoretical Exam**	- All Previous Topics	1	2
9	**Introduction to Digital Filters**	– FIR vs. IIR filters – Implementation/realization structures	1	2
10	**FIR Filter Design**	– Properties of linear phase FIR	1	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		filters – Window design techniques – Frequency sampling design techniques – Optimal equi-ripple design technique		
11	**IIR Filter Design**	– Characteristics of classical analog filters – Design using transformation methods	1	2
12	**Report & Presentation**	– 3 to 4 students make report and present the seminar on the one biomedical signal processing.	1	2
13	**Application in medical signals.**	– ECG Artifact Removal	1	2
14	**Application in medical signals.**	– ECG Arrhythmia detection	1	2
15	**Application in medical signals.**	– Brain-Computer Interface Signal Processing	1	2
16	**Final Theoretical Exam**	- All Topics	1	2
Number of Weeks /and Units Per Semester			**16**	**32**

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	- Introduction to Signal Processing and Matlab software	1	2
2	- Discrete-Time Signals and Operations by using Matlab software	1	2
3	- Continuous-Time Signals and Operations by using Matlab software	1	2
4	- Frequency Analysis of Discrete-Time Signals by using Matlab software	1	2
5	- Frequency Analysis of Continuous-Time Signals by using Matlab software	1	2
6	- Sampling Theory and Practice by using Matlab software	1	2
7	- Midterm Practical Exam	1	2
8	- Frequency Analysis of Discrete-Time Systems by using Matlab software	1	2
9	- Frequency Analysis of Continuous-Time Systems by using Matlab software	1	2
10	- Applications of biomedical signals processing (ECG Artifact Removal).	1	2
11	- Applications of biomedical signals processing (ECG Arrhythmia detection).	1	2
12	- Applications of biomedical signals processing (Brain-Computer Interface Signal Processing).	1	2

B. Case Studies and Practical Aspect:			
No.	**Tasks/ Experiments**	**Number of Weeks**	**Contact Hours**
13	- Applications of biomedical signals processing (Brain-Computer Interface Signal Processing).	1	2
14	- Practical Project	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,
- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Workshops practices,
- Directed self- study,
- Problem based learning,
- Team work (cooperative learning),
- Field visits/training,
- Mini/major project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),

VI. Assessment Methods of the Course:

- Short reports,
- Lab\Project report
- Practical lab performance assessment,
- Coursework activities assessment,
- Presentations.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1				
2				
3				
4				
5				
Total				

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	**Quiz 1**	6	5	3.33%
2	**Midterm Practical Exam**	7	20	13.33%
3	**Midterm Theoretical Exam**	8	10	6.67%
4	**Report, Presentation, and Project**	12, 13	20	13.33%

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
5	**Quiz 2**	12	5	3.33%
6	**Final Practical Exam**	15	30	20%
7	**Final Theoretical Exam**	16	60	40%
Total			**150**	**100%**

IX. Learning Resources:

- *Written in the following order:*
- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two):

1- John R. Buck, Alan V. V. Oppenheim, Alan V. Oppenheim, and Ronald W. Schafer, 2021, **Discrete-Time Signal Processing**, 3rd Edition, Prentice-Hall Signal Processing Series

2- C. Sidney Burrus, James C. McClellan, et al., 1993, **Computer-Based Exercises for Signal Processing Using Matlab**, Prentice Hall.

2- Essential References:

3- ALAN OPPEHIOHN, 2015, " **Signal processing**", 3rd Ed, USA, Elsevier Inc.

4- Hykin., 2017, **"Principles of signal processing Engineering",** UK, Artech House.

5- Joseph D. Bronzino, Donald R. Peterson., 2015, "**The signal processing Engineering Handbook: .**", 4th Ed, USA, CRC Press.

3- Electronic Materials and Web Sites etc.:

Websites:

1- The Biomedical Engineering Society (BMES) is the professional society for biomedical engineering and bioengineering. Founded in early 1968.
https://www.bmes.org/

2- BMES is a Sponsored Student Organization (SSO) comprised of a group of students who are

IX. Learning Resources:

interested in the biomedical engineering field and in networking with industry, peers, faculty, and alumni.
http://www.bmes.bme.umich.edu/

Journals:

3- *Biomedical Engineering journal* covers recent advances in the growing field of biomedical technology, instrumentation, and administration.
https://www.springer.com/journal/10527

4- Journal of Biomedical Engineering provides a forum for the publication of the latest developments in biomedical engineering, and reflects the essential multidisciplinary nature of the subject.
https://www.sciencedirect.com/journal/journal-of-biomedical-engineering

Other Web Sources:

5- Biomedical engineering forums.
https://www.ebme.co.uk/forums/

X. Course Policies:

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	**Tardy:** 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.