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

Biomedical Image Processing

Course No. (07.02.719)

2023/2024

Prepared by:	Reviewed by:	Head of the	Quality Unit:	Dean:

		Department:		
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:	Vice Dean for Quality affairs	Dean of College:
Dr. Ammar Ali Ali Abdu	Dr. -----…….	Dr. -----…….	Dr. …….....	Dr. ……..

I. Course Identification and General Information:

1	Course Title:	Biomedical Image Processing			
2	Course Code & Number:	07.02.719			
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):	(Computer Programming 2) & (Biomedical Digital Signals Processing)			
6	Co –Requisite (if any):	N/A			
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:

This course provides students with fundamentals, concepts and theories related to digital image

processing in biomedical imaging systems. Digital image processing (DIP) field has wide range

applications in biomedical devices such as, diseases diagnostics & classification. Course topics

include, an introduction to Vision Systems & DIP in biomedical, Image Representation &

Processing, image enhancement in spatial & frequency domains, Images Restoration & Segmentation and Image Compression. Throughout Computer-based lab & term-project works, students will verify learned theories and develop their problem-solving skills related to the DIP and the analysis & design of algorithms to meet biomedical imaging systems issues.

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	Identify applications of digital signal processing and how this is used in modern biomedical equipment's.	A1	Explain the appropriate models, theories, mathematical foundations, and techniques related to biomedical engineering technology context.
a2	Demonstrate and represent real world signals digital format and understand transform-domain representation of the signals.	A2	Clarify the biomedical devices maintenance principles and how these are important for solving biomedical devices and equipment's problems in health environment.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:			

b1	Apply well-organized DIP steps to the design and development of DIP software applicable to biomedical imaging field.	B1	Use the basic science, mathematical theories, engineering principles to analyze the problems of devices and/or processes relevant to biomedical engineering fields.
b2	Evaluate different filtering, segmentation and restoration techniques & methods, based on their features, capabilities and parameters.		
b3	Evaluate systems in terms of general quality attributes and possible tradeoffs presented within the given problem.		
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:			
c1	Write inventive MATLAB/Python programs for solving biomedical engineering problems related to digital images processing.	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	Use MATLAB software and/or Python programming language for modeling & analyzing of DI enhancement, segmentation and restoration algorithms.	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	Function effectively in performing individual duty & team responsibilities.	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	Identify applications of digital signal processing and how this is used in modern biomedical equipment's.	▪ Lectures ▪ Discussion ▪ Assignment ▪ Self-learning	▪ Written Exam and quizzes. ▪ Observations. ▪ Reports evaluation.
a2	Demonstrate and represent real world.		
(B) Alignment of Course Intended Learning Outcomes (Intellectual Skills) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
b1	Formulate biomedical engineering problems in terms of MSP tasks.	▪ Exercises and problems solving. ▪ Discussion. ▪ Assignment. ▪ Discussion. ▪ Lab experiment.	▪ Written Exam and quizzes. ▪ Observations. ▪ Reports evaluation.
b2	Analyze digital and analog signals and system compare different signal processing strategies.		
b3	Evaluate systems in terms of general quality attributes and possible tradeoffs presented within the given problem.		
(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	Apply basic math , science,	▪ Lab experiments	▪ Reports evaluation.

	and engineering to process signals analytically and numerically using MATLAB	▪ Discussion. ▪ Training at computer labs(Simulation)	▪ Observations.
c2	Use computers and MATLAB program to create, analyze and process signals, and to simulate and analyze systems sound and image synthesis and analysis.		

(D) Alignment of Course Intended Learning Outcomes (Transferable Skills) to Teaching Strategies and Assessment Methods:

	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
d1	Work effectively as an individual and as a member of a 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 & Course Orientations**	– Course Orientations: Course Topics, Aims & Objectives, Tools and Applications, – Machine Vision, Computer Vision, Fields of Computer Vision.	1	2	a1
2	**Introduction to DIP & Medical Images.**	– Digital Image Processing: Steps, Fundamentals, Image Sampling & Quantization, – Image Representations & Transformations, and DIP System Elements,	2	2	a1,a2

		– Medical Image: Fundamentals, Types, History & Applications.			
3	**Digital Image Acquisition & Basic Operations**	– Digital Image Acquisition System, – Basic Image Operations: Image Elements & Basic Operations, Image Pixels, Relationships between Image's Pixels, – Image Pixels & Regions Adjacency, Distances and Paths.	3	2	a1,a2,b1 ,
4	**Image Enhancement**	– Spatial Domain Enhancement Methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Filters, Sharpening Filters, – Frequency Domain Enhancement Methods: Fundamentals of Frequency Domain Filtering, Image Smoothing (Low-Pass Filter), Image Sharpening (High-Pass Filter), Selective Filters (Band Pass/Block Filters).	4	2	a2,b1,b2
5	**Digital Image Programming**	– Digital Image Programming: Use of MATLAB and/or Python Programming, Basic DI manipulation Function, Image Representation, Transformation, and Plotting	5	2	a1, ,c2
6	**Mid-Term Theoretical Exam**	– All Previous Topics	6	2	a1, a2, b1, b2
7	**Image Segmentation**	– Introduction to image segmentation, Point, Line and Edge Detection, Region based segmentation., – Classification of segmentation	7	2	a2, b1, b2

		techniques, Region approach to image segmentation, clustering techniques, Image segmentation based on thresholding, Edge based segmentation, Edge detection and linking, Hough transform and Active contour.			
8	**Image Restoration & Shape Analysis**	– Introduction to Image restoration, Image degradation, Types of image blur, – Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques, and Blind deconvolution	8	2	a1, a2, b1, b2
9	**Image Registration & Shape Analysis**	– Image Registration: Definition, Purpose, bases, Similarity Measures, Optimization & Example, – Shape Analysis: Area, Perimeter, Axes, Aspect Ratio, Compactness, Convexity, Solidity and Fiber Length.	9	2	b1, b2
10	**Image Compression**	– Image Compression: Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes, – Fundamentals of information theory, Run. length coding, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression, Image compression standard, – Wavelet -based image compression, JPEG Standards.	10	2	b1,b2

11	Final Theoretical Exam	– ALL Topics	11	2	a1, a2, b1, b2
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	Laboratory Initialization and Rules and Matlab overview.	1	2	a1,a2 ,b1,b2, c1,c2,d1
2	Discrete and Continuous-Time Signals.	2	4	
3	Discrete-Time Signals	2	4	
4	Frequency Analysis	1	2	
5	Sampling and Reconstruction	2	4	
6	Digital filter Design	2	4	
7	DFT and FFT	2	4	
Number of Weeks /and Units Per Semester		12	24	

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

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Dr. Ammar Ali Ali Abdu	Dr. -----.....	Dr. -----.....	Dr.	Dr. .....

VII. Assignments:

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
1	Discrete Time Fourier Transform	4	2.5	a2
2	Digital filters	12	2.5	b1,b2
Total			5	

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	Attendance for lectures	weekly	7	7%	a1,a2,b1,b2,c1,c2
2	Homework / Tasks /Assignments	4,12	5	5%	a1,a2,b1,b2,c1,c2,d1
3	Quiz 1	6	1.5	1.5%	a1,a2,b1,b2,c1
4	Midterm Exam	8	15	15%	a1,a2,b1,b2,c1,c2
5	Quiz 2	14	1.5	1.5%	a1,a2,b1,b2,c1
6	Labs	1,2,...14	20	20%	a1,a2,b1,b2,c1,c2
7	Final Exam	16	50	50%	a1,a2,b1,b2,c1,c2,d1
Total			100	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two)

• Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher). Example 1- Niku, Saeed B., 2011, Introduction to Robotics: Analysis, Control, Applications, 2nd Edition, USA, Wiley.

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

-1 Rafael C. Gonzalez, Richard E. Woods 2017, Digital Image Processing, 4th edition, Pearson.

2- Stan Birchfield, 2017, Image Processing and Analysis, 1st edition,

2- Essential References:

1- . S.Jayaraman, S.Esakkirajan and T.VeeraKumar, 2009, Digital Image processing, TataMcGraw Hill publisher.

2. Atam Dhawan, Medical Image Analysis, second edition, WILEYISBN: 978-0-470- 62205 -6.

3. J. Prince and J. Links, Medical Imaging, Signals and Systems, ISBN: 0-13-065353-5..

4. Vipula Singh, Digital Image Processing with MATLAB and Labview, Elsevier.

3- Electronic Materials and Web Sites etc.:

Websites:

1- Some Images & Data are taken from:
http://www.mips.stanford.edu/public/video_lectures/index.adp
http://www.math.ucla.edu/~gilboa/PDE-based_image_filtering.html

2- Some Materials and Data: http://www.cs.sunysb.edu/˜mueller/

3- Other Web Sources: Documentation on Matlab and the Image Processing Toolbox can be found on the Mathworks' Web site at https://www.mathworks.com/help/

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

1	**Class Attendance:** Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds (15 without excuses 25% with excuses).

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Dr. Ammar Ali Ali Abdu	Dr. -----.....	Dr. -----.....	Dr.	Dr. .....

2	**Tardiness:** A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
3	**Exam Attendance/Punctuality:** No student shall be allowed to the exam hall after 30 minutes of the start time, and shall not leave the hall before half of the exam time has passed.
4	**Assignments & Projects:** Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	**Cheating:** Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
6	**Forgery and Impersonation:** Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
7	**Other policies:** The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.

Second Part of Course Specification

Faculty of Medical Technology

Department of Biomedical Engineering Technology

Course Specification of

Biomedical Image Processing

Course No.)07.02.719)

Prepared by:	Reviewed by:	Head of the Department:	Vice Dean for Quality affairs	Dean of College:
Dr. Ammar Ali Ali Abdu	Dr. -----……	Dr. -----……	Dr. ……..	Dr. ……..

Biomedical signals processing

Course No. (07.02.732)

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:	Vice Dean for Quality affairs	Dean of College:
Dr. Ammar Ali Ali Abdu	Dr. -----……	Dr. -----……	Dr. ……	Dr. ……

I. Course Identification and General Information:

	Course Title:	Biomedical Image Processing			
2	**Course Code & Number:**	Course No. (07.02.719)			
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):**	(Computer Programming 2) & (Biomedical Digital Signals Processing),			
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:

This course provides students with fundamentals, concepts and theories related to digital image

processing in biomedical imaging systems. Digital image processing (DIP) field has wide range

applications in biomedical devices such as, diseases diagnostics & classification. Course topics

include, an introduction to Vision Systems & DIP in biomedical, Image Representation &

Processing, image enhancement in spatial & frequency domains, Images Restoration & Segmentation and Image Compression. Throughout Computer-based lab & term-project works, students will verify learned theories and develop their problem-solving skills related to the DIP and the analysis & design of algorithms to meet biomedical imaging systems issues.

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	Identify applications of digital signal processing and how this is used in modern biomedical equipment's.
a2	Demonstrate and represent real world signals digital format and understand transform-domain representation of the signals.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Formulate biomedical engineering problems in terms of MSP tasks.
b2	Analyze digital and analog signals and compare different signal processing strategies.
b3	Evaluate systems in terms of general quality attributes and possible tradeoffs presented within the given problem.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Apply basic math , science, and engineering to process signals analytically and numerically using MATLAB.

c2	Use computers and MATLAB program to create, analyze and process signals, and to simulate and analyze systems sound and image synthesis and analysis.
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Work effectively as an individual and as a member of a team.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	**Introduction & Course Orientations**	– Course Orientations: Course Topics, Aims & Objectives, Tools and Applications, – Machine Vision, Computer Vision, Fields of Computer Vision.	1	2	a1
2	**Introduction to DIP & Medical Images.**	– Digital Image Processing: Steps, Fundamentals, Image Sampling & Quantization, – Image Representations & Transformations, and DIP System Elements, – Medical Image: Fundamentals, Types, History & Applications.	2	2	a1,a2
3	**Digital Image Acquisition & Basic Operations**	– Digital Image Acquisition System, – Basic Image Operations: Image Elements & Basic Operations, Image Pixels, Relationships between Image's Pixels, – Image Pixels & Regions	3	2	a1,a2,b1,

		Adjacency, Distances and Paths.			
4	**Image Enhancement**	– Spatial Domain Enhancement Methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Filters, Sharpening Filters, – Frequency Domain Enhancement Methods: Fundamentals of Frequency Domain Filtering, Image Smoothing (Low-Pass Filter), Image Sharpening (High-Pass Filter), Selective Filters (Band Pass/Block Filters).	4	2	a2,b1,b2
5	**Digital Image Programming**	– Digital Image Programming: Use of MATLAB and/or Python Programming, Basic DI manipulation Function, Image Representation, Transformation, and Plotting	5	2	a1, ,c2
6	**Mid-Term Theoretical Exam**	– All Previous Topics	6	2	a1, a2, b1, b2
7	**Image Segmentation**	– Introduction to image segmentation, Point, Line and Edge Detection, Region based segmentation., – Classification of segmentation techniques, Region approach to image segmentation, clustering techniques, Image segmentation based on thresholding, Edge based segmentation, Edge detection and linking, Hough transform and Active contour.	7	2	a2, b1, b2
8	**Image Restoration**	– Introduction to Image restoration, Image degradation, Types of image blur,	8	2	a1, a2, b1, b2

	& Shape Analysis	– Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques, and Blind deconvolution			
9	Image Registration & Shape Analysis	– Image Registration: Definition, Purpose, bases, Similarity Measures, Optimization & Example, – Shape Analysis: Area, Perimeter, Axes, Aspect Ratio, Compactness, Convexity, Solidity and Fiber Length.	9	2	b1, b2
10	Image Compression	– Image Compression: Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes, – Fundamentals of information theory, Run. length coding, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression, Image compression standard, – Wavelet -based image compression, JPEG Standards.	10	2	b1,b2
11	Final Theoretical Exam	– ALL Topics	11	2	a1, a2, b1, b2
Number of Weeks /and Units Per Semester			16	32	

B. Case Studies and Practical Aspect:

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No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	Laboratory Initialization and Rules and Matlab overview.	1	2
2	Discrete and Continuous-Time Signals.	2	4
3	Discrete-Time Signals	2	4
4	Frequency Analysis	1	2
5	Sampling and Reconstruction	2	4
6	Digital filter Design	2	4
7	DFT and FFT	2	4
Number of Weeks /and Units Per Semester		12	24

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
1	Discrete Time Fourier Transform	4	2.5
2	Digital filters	12	2.5
Total			5

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Attendance for lectures	weekly	7	7%
2	Homework / Tasks /Assignments	4,12	5	5%
3	Quiz 1	6	1.5	1.5%
4	Midterm Exam	8	15	15%
5	Quiz 2	14	1.5	1.5%
6	Labs	1,2,...14	20	20%
7	Final Exam	16	50	50%
Total			100	100%

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