Syllabus

Quantitative Analysis of Medical Images (140508342) Second Semester

2021 /2022

COURSE INFORMATION	
Course Name: Quantitative Analysis of Medical Images **Semester:** Second **Department:** Department of Medical Imaging **Faculty:** Applied Medical Sciences	**Course Code:** 140508342 **Section:** Analysis and Diagnosis of Medical Images **Core Curriculum**: Radiological and Medical Imaging
Day(s) and Time(s): Thursday: 18:00 – 20:00 (Distance Education) Lab - Thursday: 14:00 – 17:00 (Distance Education) **Classroom:** Microsoft Teams Platform	**Credit Hours:** 3 **Prerequisites**: 140508341

COURSE DESCRIPTION

This course is intended to introduce the student what computers can do on various medical images rather than explaining the mathematical concepts of digital image processing DIP science. The course will explain the potential of various aspects of DIP on medical images. Applying the DIP aspects provides clinicians with more accurate picture of disease state. In addition, it allows clinicians to extract quantitative information from images in an effort to help identify disease earlier, predict prognosis, and assess treatment efficacy as well. The course is supplied with many figures of various medical images that show the potential of computer to manipulate the original medical image in which it improves the diagnosis process taking by the radiologist. The departmental image analysis lab provides hands-on further practical demonstrations.

So, this course is planned to offer the student with the various image processing and analysis methods commonly (and commercially) used in medical imaging applications such as histogram processing, image smoothing, image sharpening, spatial co-registration, segmentation, and feature extraction. Furthermore, different quantitative analysis methods such as region volume of interest, and algorithms of object recognition and classifications (i.e. the computer aided detection or diagnosis of lesions), and measurements on images will also be introduced in this course.

DELIVERY METHODS

The course will be delivered through a combination of active learning strategies. These will include:

- PowerPoint lectures and active classroom based discussion.
- Collaborative learning through small groups acting in an interdisciplinary context.
- Relevant films and documentaries.
- Video lectures.
- E-learning resources: e-reading assignments and practice quizzes through Model and Microsoft Team.

FACULTY INFORMATION

Name	*Ali Mohammad Ibrahim Al-Radaideh*
Academic Title:	*Professor*
Office Location:	*Applied Medical Sciences 3165*
Telephone Number:	*5590*
Email Address:	*ali.radaideh@hu.ed.jo*
Office Hours:	*Sunday/Tuesday: 12:30-1:30* *Monday: 12:30-1:30*
	Please send an e-mail (ali.radaideh@hu.edu.jo) to meet at any other time.

REFERENCES AND LEARNING RESOURCES

Required Textbook:

There is no required textbook for purchase.
All compulsory weekly readings are available electronically on Microsoft Teams and "Dr-Ali Al-Radaideh_Teaching files" on Facebook group.

Suggested textbook for reading:

Digital Image Processing for Medical Applications: An introduction, Geoff Dougherty, CAMBRIDGE, 2009.

STUDENT LEARNING OUTCOMES MATRIX*

Core Curriculum Learning Outcomes	Program Learning Outcomes	Course Objectives	Course Student Learning Outcomes	Assessment Method
Think critically and creatively in a variety of methods in order to make diagnostic decisions and	KP1: Develop an understanding of human anatomy and physiology as it relates to health and disease and acquire competency in	1. To understand the potential of computers on medical images.	Is able to evaluate the importance of digital images and find out the draw backs of conventional ones.	• Exams • Quizzes • "On-line' reading assignments • homework assignments

solve problems. Communicate competently with others using oral and written English skills	medical terminology, documentation KP2: Understand the principles and physics of medical imaging technologies such as general X-ray, CT, MRI, ultrasound, fluoroscopy, nuclear medicine, dental radiography, and mammography and relate medical research KP3: Develop and implement protocols for medical imaging procedures, including patient positioning, patient care, proper exposure factor selection, appropriate radiation protection measures, demonstrating technical competence, and the use of contrast agents SP1: Demonstrate depth of knowledge and integrate it of the basic scientific principles of all medical imaging technologies for the implementation of various protocols and techniques and to conduct scientific research in this field SP2: Use creativity, critical thinking, analysis, and research skills to modify standard procedures to adapt to new circumstances, difficult cases, or unusual situations while maintaining	2. To understand the common and commercial DIP aspects installed in medical imaging systems such as: filtering, smoothing, sharpening, dealing with images interactively to extract regions and make measurements.	Be able to apply the common and commercial DIP aspects installed in medical imaging systems such as: filtering, smoothing, sharpening, dealing with images interactively to extract regions and make measurements.	• Exams • Quizzes • "On-line' reading assignments • homework assignments
		3. To understand the common digital image terminology used in medical image systems such as: histogram, types of 3- D visualization, restoration and registration.	Be able differentiate the common digital image terminology used in medical image systems such as: histogram, types of 3-D visualization, restoration and registration.	• Exams • Quizzes • "On-line' reading assignments • homework assignments
		4. To understand the computers algorithms provided by	Be able to deal with different computers algorithms provided by manufacturers and vendors for	• Exams • Quizzes

	appropriate medical imaging quality. SP3: Evaluate and criticize all types of medical images CP1: Access, evaluate, and provide medical imaging requirements CP2: Recognizing the need to learn from professional learning, managing learning in the field of medical imaging in an integrated manner, and acquiring continuous learning skills CP3: Demonstrate professional identity and responsibility with patients, colleagues, employers, and society, with ethical and professional behaviors and attitudes in the practice of health care. CP4: Produces high quality, diagnosable medical images by applying positioning skills, selecting technical parameters, and using radiation protection.			

		manufacturers and vendors for medical image analysis such as: computer aided detection; computer aided diagnosis, and automated measurements.	medical image analysis such as: computer aided detection; computer aided diagnosis, and automated measurements.	• "On-line' reading assignments • homework assignments

		5- To build up familiarity with computers as they are part of all digital medical imaging systems (i.e. Digital Radiography).	Be able to understand the importance of integration of digital imaging in all part of medical imaging systems.	• Exams • Quizzes • "On-line' reading assignments • homework assignments

ACADEMIC SUPPORT

It is the Hashemite University policy to provide educational opportunities that ensure fair, appropriate and reasonable accommodation to students who have disabilities that may affect their ability to participate in course activities or meet course requirements. Students with disabilities are encouraged to contact their Instructor to ensure that their individual needs are met. The University through its special need section will exert all efforts to accommodate for individual's needs.

COURSE REGULATIONS

Participation

Class participation and attendance are important elements of every student's learning experience at The Hashemite University, and the student is expected to attend all classes. A student should not miss more than 15% of the classes during a semester. *Those exceeding this limit of 15% will receive a failing grade regardless of their performance*. It is a student's responsibility to monitor the frequency of their own absences. **Attendance record begins on the first day of class irrespective of the period allotted to drop/add and late registration. It is a student's responsibility to sign-in; failure to do so will result in a non-attendance being recorded.**

In exceptional cases, the student, with the instructor's prior permission, could be exempted from attending a class provided that the number of such occasions does not exceed the limit allowed by the University. The instructor will determine the acceptability of an absence for being absent. A student who misses more than 25% of classes and has a valid excuse for being absent will be allowed to withdraw from the course.

Plagiarism

Plagiarism is considered a serious academic offence and can result in your work losing marks or being failed. HU expects its students to adopt and abide by the highest standards of conduct in their interaction with their professors, peers, and the wider University community. As such, a student is expected not to engage in behaviours that compromise his/her own integrity as well as that of the Hashemite University.

Plagiarism includes the following examples and it applies to all student assignments or submitted work:

- **Use of the work, ideas, images or words of someone else without his/her permission or reference to them.**
- **Use of someone else's wording, name, phrase, sentence, paragraph or essay without using quotation marks.**
- **Misrepresentation of the sources that were used.**

The instructor has the right to fail the coursework or deduct marks where plagiarism is detected

Late or Missed Assignments

In all cases of assessment, students who fails to attend an exam, class project or deliver a presentation on the scheduled date without prior permission, and/or are unable to provide a medical note, will automatically receive a fail grade for this part of the assessment.

- Submitting a term paper on time is a key part of the assessment process. Students who fail to submit their work by the deadline specified will automatically receive a 10% penalty. Assignments handed in more than 24 hours late will receive a further 10% penalty. Each subsequent 24 hours will result in a further 10% penalty.
- In cases where a student misses an assessment on account of a medical reason or with prior permission; in line with University regulations an incomplete grade for the specific assessment will be awarded and an alternative assessment or extension can be arranged.

Student Complaints Policy

Students at The Hashemite University have the right to pursue complaints related to faculty, staff, and other students. The nature of the complaints may be either academic or non-academic. For more information about the policy and processes related to this policy, you may refer to the students' handbook.

COURSE ASSESSMENT

Course Calendar and Assessment

Students will be graded through the following means of assessment and their final grade will be calculated from the forms of assessment as listed below with their grade weighting taken into account. The criteria for grading are listed at the end of the syllabus

Assessment	Grade Weighting	Deadline Assessment
Exam 1	20%	05/4/2022 12:30 – 1:30
Exam 2	20%	110/5/2022 12:30 – 1:30
Lab and intercourse assessment	20%	
Final Exam	40%	To be announced by the registration office

Description of Exams

Test questions will predominately come from material presented in the lectures. Semester exams will be conducted during the regularly scheduled lecture period. Exam will consist of a combination of multiple choice, short answer, match, true and false and/or descriptive questions.

Homework:

Will be given for each chapter, while the chapter in progress you are supposed to work on them continuously and submit in next lecture when I finish the chapter.

You are also expected to work on in-chapter examples, self-tests and representative number of end of chapter problems. The answers of self-tests and end of chapter exercises are given at the end of the book.

Quizzes:

Unannounced quizzes will be given during or/and at the end of each chapter based upon the previous lectures. It will enforce that you come prepared to the class.

No make-up exams, homework or quizzes will be given. Only documented absences will be considered as per HU guidelines.

Grades are not negotiable and are awarded according to the following criteria*:

Letter Grade	Description	Grade Points
A+	Excellent	4.00
A		3.75
A-		3.50
B+	Very Good	3.25
B		3.00
B-		2.75
C+	Good	2.50
C		2.25
C-		2.00
D+	Pass	1.75
D	Pass	1.50
F	Fail	0.00
I	Incomplete	-

WEEKLY LECTURE SCHEDULE AND CONTENT DISTRIBUTION

"Lecture hours and weeks are approximate and may change as needed"

Part One 1	**Introduction to Image Processing**	**Week 1-2**	**4 lecture hours**
1.1 Review of Medical images obtained with ionizing and non-ionizing radiation			
1.2 The DIP System			
1.3 Medical Applications of DIP			
1.4 Color Images			
1.5 Medical Image Formats			
Part Two:	**Fundamentals Concepts of Image Processing**	**Week 3-6**	**8 lecture hours**
2.1 Histogram Processing: Definition, Equalization, Matching			
2.2 Image enhancement in the spatial domain Image Intensity Transformations Image Smoothening and Sharpening			
2.3 Image enhancement in the frequency domain Basic Principle Image Frequency filters			
2.4 Image restoration Image degradation Noise reduction filters Geometric degradation.			
Part Three	**Image Analysis**	**Week 7-10**	**8 lecture hours**
3.1 Image segmentation Thresholding Region Based Segmentation			

Boundary based Segmentation (Edge Detection) Other Methods			
3.2 Feature recognition and classification Features Objects recognition and classifications Application in medical image analysis Common Classifiers			
3.3 Three-dimensional visualization Image visualization Surface rendering Volume rendering Virtual reality			
3.4 Statistical metrics on Medical Images Receiver Operating characteristics Curves Statistical Parametric Model			
Part Four	**Medical applications**	**Week 11-14**	**8 lecture hours**
4.1 Computer Aided detection			
4.2 Tumor Imaging and treatment			
4.3 Computer Aided diagnosis			
4.4 Angiography			
4.5 Bone strength and osteoporosis			
4.6 Tortuosity			
Review		***Week 15***	
University Exams		***Week 16***	

Classroom Participation: Assessment Criteria					
	Quality				Score
Criteria	Excellent (5 points)	Good (4 points)	Satisfactory (3 points)	Needs Improvement (2 points)	
Degree to which student integrates course readings into classroom participation	often cites from readings; uses readings to support points; - often articulates "fit" of readings with topic at hand.	-occasionally cites from readings; - sometimes uses readings to support points; -occasionally articulates "fit" of readings with topic at hand .	-rarely able to cite from readings; - rarely uses readings to support points; - rarely articulates "fit" of readings with topic at hand	-unable to cite from readings; -cannot use readings to support points; cannot articulates "fit" of readings with topic at hand .	
Interaction/ participation in classroom discussions	-always a willing participant, responds frequently to questions; - routinely volunteers point of view .	-often a willing participant, - responds occasionally to questions; - occasionally volunteers point of view .	-rarely a willing participant, - rarely able to respond to questions; - rarely volunteers point of view .	-never a willing participant., - never able to respond to questions; - never volunteers point of view .	
Interaction/partici pation in classroom learning activities	-always a willing participant; -acts appropriately during all role plays; - responds frequently to questions; - Routinely volunteers point of view.	-often a willing participant; -acts appropriately during role plays; - responds occasionally to questions; -occasionally volunteers point of view.	-rarely a willing participant. -occasionally acts inappropriately during role plays; - rarely able to respond to direct questions; -rarely volunteers point of view.	-never a willing participant - often acts inappropriatel y during role plays;, - never able to respond to direct questions; - never volunteers point of view.	
Demonstration of professional attitude and demeanor	-always demonstrates commitment through thorough preparation; - always arrives on time; - often solicits instructors' perspective outside class.	rarely unprepared; rarely arrives late; - occasionally solicits instructors' perspective outside class .	-often unprepared; occasionally arrives late; - rarely solicits instructors' perspective outside class .	-rarely prepared; - often arrives late; -never solicits instructors' perspective outside class	

ASSESSMENT RUBRICS										
Classroom Participation: Oral Presentation										
Element	**Excellent**			**Satisfactory**			**Needs Improvement**			**Points**
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Organization	▪ There is a logical sequence of information. ▪ Title slide and closing slide are included appropriately.			▪ There is some logical sequence of information. ▪ Title slide and closing slides are included.			▪ There is little or no logical sequence of information. ▪ Title slide and/ or closing slides are not included.			
Slide Design (text, colors, background, illustrations, size, titles, subtitles)	▪ Presentation is attractive and appealing to viewers.			▪ Presentation is somewhat appealing to viewers.			▪ Little to no attempt has been made to make presentation appealing to viewers.			
Content	▪ Presentation covers topic completely and in depth. ▪ Information is clear, appropriate, and accurate.			▪ Presentation includes some essential information. ▪ Some information is somewhat confusing, incorrect, or flawed.			▪ Presentation includes little essential information. ▪ Information is confusing, inaccurate, or flawed.			
Language	▪ Spelling, grammar, usage, and punctuation are accurate ▪ Fluent and effective			▪ There are minor problems in spelling, grammar, usage, and/or punctuation.			▪ There are persistent errors in spelling, grammar, usage, and/or punctuation. ▪ Less or not fluent and effective.			
Delivery	▪ Ideas were communicated with enthusiasm, proper voice projection and clear delivery. ▪ There was sufficient eye contact with audience. ▪ There were sufficient use of other non-verbal communication skills. ▪ Appropriate delivery pace was used.			▪ There was some difficulty communicating ideas due to voice projection, lack of preparation, incomplete work, and/or insufficient eye contact. ▪ Insufficient use of non-verbal communication skills. ▪ Delivery pace is somewhat appropriate.			▪ There was great difficulty communicating ideas due to poor voice projection, lack of preparation, incomplete work, and/or little or no eye contact. ▪ No use of non verbal communication skills. ▪ Inappropriate delivery pace was used.			

Interaction with Audience	▪ Answers to questions are coherent and complete. ▪ Answers demonstrate confidence and extensive knowledge.	▪ Most answers to questions are coherent and complete. ▪ Answers somehow demonstrate confidence and extensive knowledge.	▪ Answers to questions are neither coherent nor complete. ▪ Is tentative or unclear in responses.	