San José State University
College of Engineering
Biomedical Engineering Department

BME 258, Medical Imaging for Engineers, Fall 2020

Course and Contact Information

Instructor:	Eveline Bellegarda PhD
Office Location:	Online
Telephone:	Email is preferred
Email:	eveline.bellegarda@sjsu.edu
Office Hours:	After class or by appointment
Class Days/Time:	Wednesdays 18:00-19:40
Classroom:	Online Live Sessions via Zoom
Computer laboratory	Saturdays 12:00-14:45 Online via Zoom
Prerequisites:	**Phys 51, EE98, Math 133A, BME 177, BME 210 (or Equivalent) or Permission of the Instructor**

Course Format

The course adopts an online delivery format. Students must have internet-connected devices (laptops, tablets or equivalent) in order to participate fully in the Wednesday online lectures and Saturday labs via Zoom. Computer-based learning activities will be held weekly on Saturdays and will be based on free open-source software, such as ImageJ (image analysis), R (statistics), and commercially available MATLAB. Recordings of lectures will be shared with the students.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the Canvas learning management system course website. All communications relevant to the course will be sent out using Canvas announcements. Students should make sure they have access to all the announcements by setting up the appropriate notification parameters on Canvas.

Canvas Discussion

Canvas discussion will be used for students to ask technical questions to the professor while allowing them to share their response to all students at once.
Student may post questions anonymously to other students (professor will see who you are). Students may also answer your questions, endorse responses made by other students, and mark duplicate questions.

To ensure fair treatment of all students and to provide students with the most rapid and consistent instructional information, **the professor will not answer technical and policy questions by email.** Technical and policy questions include those regarding homework content, exam content, assignment deadlines, etc. Students should instead post to the class discussion board.

Email Policy
Please send **emails regarding personal issues** (academic integrity issues, personal grades, medical issues, etc.) to the professor. To receive the most rapid response to your email message, please start the subject line with the characters "**BME258**". Out of fairness to all students, email communications related to technical questions or course policy will *not* be returned (please post these types of questions to the discussion board).

Course Description

An introduction to the principles and clinical applications of medical imaging. Fundamentals of digital image acquisition and manipulation. Physical principles: interaction of radiation with matter. Image resolution, quality and artifacts. Clinical imaging techniques: X-ray planar radiography and computed tomography, ultrasound imaging, magnetic resonance imaging. Safety of medical imaging. Computer laboratory: clinical image analysis; image enhancement, segmentation, contouring; feature recognition.

Learning Outcomes

The fundamental objectives of this course are (a) to introduce students to the underlying physics, mathematics and engineering concepts of modern medical imaging, and (b) to have the students learn how medical images are collected and processed and how they can be used for diagnosis and therapy.

Learning objectives

- understand the basic physical concepts of how biological components of our bodies lead to contrast in medical images.
- describe the major components of most standard medical imaging systems, including radiography, computed tomography, ultrasound, and magnetic resonance imaging systems.
- obtain a basic understanding of how data are acquired by each scanner, how data are processed, how images are reconstructed, how these data are analyzed and how the results are interpreted
- identify the preferred medical imaging methods for routine clinical applications.
- understand the biologic effects of the different types of radiation and contrast agents used in medical imaging and discuss principles and issues of safety of medical imaging.
- compare and contrast the role of different imaging modalities in providing anatomical and physiological information about the human body within limits imposed by the physical and engineering design constraints of each modality.
- solve qualitative and quantitative problems related to medical image acquisition
- assess quality and artifact issues of medical images acquired from different techniques.
- analyze medical images utilizing basic image processing techniques, including image enhancement, segmentation and contouring.
- analyze and criticize peer-reviewed publications on medical imaging.

Required Texts/Readings

Textbook

Nadine B. Smith and Andrew Webb, Introduction to Medical Imaging: Physics, Engineering and Clinical Applications, 1st Edition, Cambridge University Press (2010).

Other Readings

- Paul Suetens, Fundamentals of Medical Imaging, 2nd Edition, Cambridge University Press (2009).
- Jerry L. Prince and Jonathan Links, Medical Imaging Signals and Systems, 2nd Edition, Prentice Hall (2014).

Library Liaison (Biomedical, Chemical & Materials Engineering Department)

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Course Requirements and Assignments

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details about student workload can be found in University Policy S12-3 at http://www.sjsu.edu/senate/docs/S12-3.pdf.

Attainment of the learning objectives (as listed above) will be assessed via homework, quizzes, discussions, computer laboratories reports, one mid-term examination, and a final examination.

Assignments

There will be about 3 to 4 homeworks to be submitted **individually** on the due date. Late assignments will not be accepted.

There will also be laboratory reports to be submitted on the due date. Late lab assignments will lose 10% per day.

Examinations

There will be one mid-semester examination, and one final examination. The midterm will cover the entire course material covered until the time of the examination. The final will be comprehensive, with an emphasis on the material seen after the midterm. The date of the mid-semester examination is indicated in the Lecture Schedule. The final examination will be held on the date specified by the university's final examination schedule**.** There will be no make-up examinations.

MOSS Code Checking

MATLAB code written for homework, lab, and/or exam questions is subject to plagiarism checking using the MOSS software (http://theory.stanford.edu/~aiken/moss/). This tool checks MATLAB code for excessive similarity against both the internet *and* code submitted by other classmates. Code that is flagged by the program and confirmed by the instructor to be excessively similar will receive a zero-score and subject to the SJSU academic integrity process. Students are free to download their own copies of the software to compare their code prior to submission.

NOTE that University policy F69-24 at http://www.sjsu.edu/senate/docs/F69-24.pdf states that "Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading."

Grading Policy

Letter Grades:

Grade	*Percentage*
A plus	*96 to 100%*
A	*93 to 95%*
A minus	*90 to 92%*
B plus	*86 to 89 %*
B	*83 to 85%*
B minus	*80 to 82%*
C plus	*76 to 79%*
C	*73 to 75%*
C minus	*70 to 72%*
D plus	*66 to 69%*
D	*63 to 65%*
D minus	*60 to 62%*

Weight of class assignments and examinations:

Midterm examination	20%
Final Examination	30%
Laboratory Reports	30%
Participation/Discussion	15%
Homework	5%

Absence during examinations and quizzes, without prior approval, will result in a zero. Prior approval will be given only under exceptional circumstances.

Note that "All students have the right, within a reasonable time, to know their academic scores, to review their grade-dependent work, and to be provided with explanations for the determination of their course grades." See University Policy F13-1 at http://www.sjsu.edu/senate/docs/F13-1.pdf for more details.

Classroom Protocol

Attendance

Students are expected to be set up for lecture by the time the class begins online. Attendance in class is not mandatory and shall not be used per se as a criterion for grading. However class attendance and participation are highly recommended.

Behavior

Students should remain respectful of each other at all times. Interruptive or disruptive attitudes are discouraged.

Assignments

Students are encouraged to collaborate on all types of assignments. However, assignments must be individually prepared and submitted by each student.

University Policies

Per University Policy S16-9 *(http://www.sjsu.edu/senate/docs/S16-9.pdf)*, relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on Syllabus Information web page (http://www.sjsu.edu/gup/syllabusinfo), which is hosted by the Office of Undergraduate Education. Make sure to visit this page to review and be aware of these university policies and resources.

Consent for Recording of Class and Public Sharing of Instructor Material

University Policy S12-7, http://www.sjsu.edu/senate/docs/S12-7.pdf, requires students to obtain instructor's permission to record the course and the following items to be included in the syllabus:

- "Common courtesy and professional behavior dictate that you notify someone when you are recording him/her. You must obtain the instructor's permission to make audio or video recordings in this class. Such permission allows the recordings to be used for your private, study purposes only. The recordings are the intellectual property of the instructor; you have not been given any rights to reproduce or distribute the material."
    - It is suggested that the greensheet include the instructor's process for granting permission, whether in writing or orally and whether for the whole semester or on a class by class basis.
    - In classes where active participation of students or guests may be on the recording, permission of those students or guests should be obtained as well.
- "Course material developed by the instructor is the intellectual property of the instructor and cannot be shared publicly without his/her approval. You may not publicly share or upload instructor generated material for this course such as exam questions, lecture notes, or homework solutions without instructor consent."

Academic integrity

Your commitment, as a student, to learning is evidenced by your enrollment at San Jose State University. The University Academic Integrity Policy S07-2 at http://www.sjsu.edu/senate/docs/S07-2.pdf requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 at http://www.sjsu.edu/president/docs/directives/PD_1997-03.pdf requires that students with disabilities requesting accommodations must register with the Accessible Education Center (AEC) at http://www.sjsu.edu/aec to establish a record of their disability.

Accommodation to Students' Religious Holidays

San José State University shall provide accommodation on any graded class work or activities for students wishing to observe religious holidays when such observances require students to be absent from class. It is the responsibility of the student to inform the instructor, in writing, about such holidays before the add deadline at the start of each semester. If such holidays occur before the add deadline, the student must notify the instructor, in writing, at least three days before the date that he/she will be absent. It is the responsibility of the instructor to make every reasonable effort to honor the student request without penalty, and of the student to make up the work missed. See University Policy S14-7 at http://www.sjsu.edu/senate/docs/S14-7.pdf.

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Tentative Course Schedule

(subject to change with fair notice)

	Session	Date	Day	Lecture topics, examinations, lab activities	Recommended Reading
Week 1	Lec1	August-19	W	Class Overview; General Image Characteristics; Survey of Imaging Modalities	Smith Ch. 1
	Lab0	August-22	S	*No lab this week*	
Week 2	Lec2	August-26	W	Image Resolution and Quality; Image Artifacts; Image Processing	Smith Ch. 1.4-1.6; (Suetens Ch. 1)
	Lab1A	August -29	S	Introduction to Image Processing	
Week 3	Lec3	September-02	W	Image Quality (Continued)	Smith Ch. 2.4 (Suetens Ch. 2)
	Lab1B	September-05	S	Lab 1 Part B	
Week 4	Lec4	September-09	W	X-Ray Planar Radiography: Physical Principles, clinical applications, safety	Smith Ch. 2.1-2.3, 2.5, 2.8-2.9, 2.10 (Suetens Ch. 2)
	Lab2A	September-12	S	Image Processing in the Spatial Domain	
Week 5	Lec5	September-16	W	Computed Tomography: Physical principles, clinical applications, safety	Smith Ch. 2.12-2.18 (Suetens Ch. 3)
	Lab2B	September-19	S	Lab 2 Part B	
Week 6	Lec6	September-23	W	Ultrasound Imaging: Physics of Acoustic Waves	Smith Ch. 4.1-4.4 (Suetens Ch. 6)
	Lab2C	September-26	S	Lab 2 Part C	
Week 7	Lec7	September-30	W	Ultrasound Imaging Modalities and Clinical Applications; Safety Issues	Smith Ch. 4.5-4.8, 4.13
	Lab3A	October-03	S	Image Processing in the Frequency Domain	
Week 8	Lec8	October-07	W	Ultrasound Imaging continued	
	Lab3B	October-10	S	Lab 3 Part B	
Week 9	Lec9	October-14	W	Midterm	
	Lab3C	October-17	S	Lab 3 Part C	
Week 10	Lec10	October-21	W	Nuclear Medical Imaging ; Radionucleides; Interaction with Tissues	Smith Ch. 3.1-3.5
	Lab4A	October-24	S	X-ray Images – Radon Transform	

Week 11	Lec11	October-28	W	Nuclear Medical Imaging Modalities and Clinical Applications	Smith Ch 3.8, 3.12, 3.21
	Lab4B	*October-31*	S	Lab 4 Part B	
Week 12	Lec12	November-04	W	Magnetic Resonance Imaging: Magnetic Fields and Interactions with Tissue	Smith Ch. 5.1-5.7 (Suetens Ch. 4)
	Lab 5	November-07	S	Working with Ultrasound Images	
Week 13		November-11	W	No class – Veterans Day – Campus closed	
	Lab 6A	November-14	S	Application of Machine Learning in Medical Imaging	
Week 14	Lec13	November-18	W	MRI: Image acquisition and Reconstruction	Smith 5.8-5.13, 5.20 (Suetens Ch 4)
	Lab 6B	November-21	S	Machine learning and Deep Learning with Medical Imaging Systems	
Week 15		November-25	W	No class – Thanksgiving recess	
		November-28	S	No Lab - Thanksgiving Holiday	
Week 16	Lec14	December-02	W	Review	
	Lab 7	December-05	*S*	TBD	
	FINAL	**December-09**	***W***	**Final Exam 17:15-19:30**	