**BME 425: Basics of Biomedical Imaging Fall 2016**

**1. Basic Information:**

*Course:* Basics of Biomedical Imaging, BME 425, 3 units
*Place and time:* RTH 109; TH 2:00 to 4:50 PM
*Faculty:* Brent J. Liu, Ph.D., Associate Professor, BME Department
*Office:* Denny Research Center (DRB), Room 264
*Email:* brentliu@usc.edu
*Office Hours:* TH 10:00 AM to 11:00 PM (by e-mail appt)
*TA:* Ximing Wang, ximingwa@usc.edu, DRB 256

*TA’s Office Hours:* TBD

**2. Course Description and Learning Objectives:**

**Description**

Engineering, clinical applications and modern physics concepts underlying X-ray imaging, Computed Tomography (CT), nuclear medicine, positron emission tomography, Magnetic Resonance Imaging (MRI), and ultrasound imaging (US).

**Learning Objectives and Specific Course Outcomes**

**Outcome 1:** Understand the underlying physics behind the most common imaging modalities: X-ray imaging, X-ray computed tomography (CT), single-photon emission computed tomography (SPECT) and positron emission tomography (PET), magnetic resonance imaging (MRI) and ultrasound imaging (US)

**Outcome 2:** Have general knowledge of how biological components (parameters) of the human body lead to contrast in these common imaging modalities. Be able to relate physical and biological parameters to engineering design of imaging instruments.

**Outcome 3:** Have a working knowledge of the Fourier and Radon transforms, how they relate to the mathematical basis of image reconstruction, and how/when they can be employed.

**Outcome 4:** Be able to apply concepts associated with sampling (including the Nyquist-Shannon sampling theorem), filtering, and basic frequency analysis.

**Outcome 5:** Be able to work as part of a team of students to complete a multi-week research project on current, state-of-the-art imaging applications, and share the results of the project through an oral presentation.

**Outcome 6:** Possess a broad knowledge of imaging technologies and the limitations or concerns associated with them in order to engage in further education or practice in the field.

*See Section 12 for complete list of BME Program Student Outcomes and relationship to the above course outcomes.*

**3. Lecture Topics**

* Radiography, computed tomography, nuclear medicine
* Magnetic resonance imaging, ultrasound imaging
* Image compression
* Image quality
* Back projection, models and equations
* Convolution
* Fourier and Radon transforms
* Sampling
* Filters
* Basics of Imaging Informatics

**4. REQUIRED Text and Source Materials:**

1. *The Essential Physics of Medical Imaging*. Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone, 3rd edition, 2011.
2. BME 425 class slides. Download from Blackboard.

**5. Grading:**

Attendance 10%

Midterm Exam 20%

Final Exam 30%

Special Project 15%

Homework (~ 4 Assignments) 25%

If you wish to dispute a grade, you must do so within *two weeks* of the posting of that grade.

**6. Exams:**

You will be allowed to bring a calculator and ONE double-sided 8.5” by 11” note page for each exam.

During an exam, please ask permission before leaving the room and do not take any electronic devices with you (phones, etc., should remain stored in your belongings until after the exam is over). A phone will not be allowed as a substitute for a calculator.

**7. Special Project:**

Groups made up of 4-5 students will each prepare a 15- to 20- minute PowerPoint presentation on the (imaging-related) topic of their choice. Students may choose their own groups, and must declare their group choices by the 3rd week of the semester. Groups must then choose their topics by week 6 of the semester. Presentations will be made in the last week of the semester.

**8. Homework:**

Homework will primarily consist of calculation and writing assignments. While you may consult with classmates regarding the homework assignments and on solution ideas, you are required to write your own homework reports. Homework solutions may not be shared. Plagiarism of another's work is a very serious offense and all suspected cases will be dealt with according to University regulations (see SCampus). It is also not acceptable to copy and paste your answers from the internet (or from the lecture notes).

There will be one special homework assignment consisting of a small programming project. This project will be released during the 3rd week of the semester and can be turned in up to the end of the last day of class. Each of the homework assignments will be worth 5% of the overall grade while the special homework assignment will be worth 10% which combines to 25% of the overall grade.

Homework assignments that require submission of a physical document are to be turned in at the beginning of class on the day they are due. For every day (or portion of a day) an assignment is late, 25% will be subtracted from its maximum point total.

**9. Statement of Academic Integrity from SJACS[[1]](#footnote-1)\*:**

The University of Southern California is primarily an academic community. As such, the university seeks to maintain an optimal learning environment. It protects its educational environment by establishing and maintaining standards of conduct for its students. These standards reflect the very nature of an academic community and the need to preserve an effective educational environment. General principles of academic integrity include and incorporate the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed, and the obligations to protect one’s work from misuse by others as well as to avoid using another’s work as one’s own. All students are expected to understand and abide by these principles (*Scampus 2010*).

Students should be aware of the expectations as outlined in the Student Conduct Code found in *SCampus* online at http://web-app.usc.edu/scampus/university-governance/. In addition USC Libraries provides an on-line tutorial for students to become familiar with standards: http://usccollege.na4.acrobat.com/academicintegrity.

**10. Webpage:**

This course uses Blackboard and can be accessed via https://blackboard.usc.edu/webapps/login/. Be sure to CHANGE or FORWARD YOUR EMAIL to the one you use most frequently, as we will send out email messages during the semester using the email address that is associated with your account on the Blackboard website.

**11. Special Accommodations:**

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to the TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 AM – 5:00 PM, Monday through Friday. The phone number for DSP is (213) 740-0776.

**12. BME Program Outcomes:**

The BME program states that students successfully completing the program should have acquired the following outcomes:

* 1. an ability to apply knowledge of mathematics, science, and engineering
	2. an ability to design and conduct experiments, as well as to analyze and interpret data
	3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
	4. an ability to function on multi-disciplinary teams
	5. an ability to identify, formulate, and solve engineering problems
	6. an understanding of professional and ethical responsibility
	7. an ability to communicate effectively
	8. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
	9. a recognition of the need for, and an ability to engage in life-long learning
	10. a knowledge of contemporary issues
	11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

This table shows the correlation between course outcomes (Section 2) and student outcomes:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Course Outcomes↓ Student Outcomes → | a | b | c | d | e | f | g | h | i | j | k |
| Outcome 1: | x |  |  |  |  |  |  |  |  |  |  |
| Outcome 2: |  |  |  |  | x |  |  |  |  |  |  |
| Outcome 3: | x |  |  |  |  |  |  |  |  |  |  |
| Outcome 4: | x | x |  |  | x |  |  |  |  |  |  |
| Outcome 5: |  |  |  | x |  |  | x |  |  | x |  |
| Outcome 6: |  |  |  |  |  |  |  |  | x |  | x |
| All Course Outcomes | x | x |  | x | x |  | x |  | x | x | x |

**13. Course Outline and Topics:**

**8/25**- Introduction & Course Syllabus; Introduction to Medical Imaging

**9/1-** The Physics of Radiation and Image Formation

**9/8**- Medical Image Fundamentals: Image Quality (Small Groups for Special Project finalized and Special Homework Assignment distributed)

**9/15**- Medical Image Fundamentals: Spatial & Frequency Domains; Image Transformation

**9/22**- Introduction to Medical Image Informatics

**9/29**- **Special Guest Lecture** (Topic chosen for Special Project)

**10/6**- MIDTERM

**10/13**- Projectional Imaging: X-Ray/Film and CR

**10/20**- Projectional Imaging: Fluoroscopy, Mammography, and DR

**10/27**- Sectional Imaging: Computed Tomography

**11/3**- Sectional Imaging: Magnetic Resonance Imaging

**11/10**- Sectional Imaging: Ultrasound and Nuclear Medicine

**11/17- Special Guest Lecture**

**11/24**- Thanksgiving Holiday: NO CLASS

**12/1** - Project Presentations and wrap up (LAST DAY of class)

1. \* SJACS: Student Judicial Affairs and Community Standards [↑](#footnote-ref-1)