BIOM 4801/6801: Introduction to Medical Imaging (Syllabus)

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BIOM 4801/6801: Introduction to Medical Imaging

Course Information

4 credit hours. Lecture and Lab format.

Instructors

• Aaryani Sajja, PhD, ET 321C; Email: Aaryani.Sajja@memphis.edu
• Carl Herickhoff, PhD, ET 321E; Email: Carl.Herickhoff@memphis.edu

Course Description

This course will introduce fundamentals of the four most-important clinical medical imaging modalities: X-ray, Radionuclide, Ultrasound, and MRI. The primary focus is on the physical principles, instrumentation methods, imaging algorithms, and clinical applications of each imaging modality.

Course Goals

After completion of the course, students should be able to:

• Describe the types of energy used for each modality and how the energy is generated.
• Discuss the basic principles and instrumentation of each modality.
• Explain the methods of image acquisition and formation for each modality.
• Apply image processing and analysis techniques.

The course will introduce the students to Medical Imaging, which is one of the focus areas in biomedical engineering that is not being offered currently. The course fulfills the requirements for an engineering elective for junior/senior year undergraduate students to get introduced to a different area in biomedical engineering and for graduate students to pursue research in medical imaging. The course may also serve as an elective for students from electrical & computer engineering with interest in image processing.

Prerequisites and Corequisites

• PHYS 2110, PHYS 2120
• MATH 1920, MATH 2110
**Course Topics**
The following are the topics that will be covered in this course:

- Introduction to basic concepts of medical imaging.
- Generation and detection of x-rays and x-ray diagnostic methods.
- Computed Tomography; Biological effects of ionizing radiation.
- Ultrasound: Acoustic fundamentals, generation and detection and diagnostic methods.
- Radionuclide imaging: fundamentals of radioactivity, radionuclide generators and detectors, radionuclide imaging methods: Scintigraphy, SPECT, PET.
- Nuclear Magnetic Resonance (NMR/MRI): fundamentals, generation and detection of MRI signal and image formation.

**Labs**

- Image format and display: reading, writing and manipulating images
- Image resolution, quantization, basic operations
- Spatial resolution, Point spread function, Convolution
- X-ray: Spectrum, Attenuation, Contrast, Signal-to-noise ratio
- CT: Sinogram, Image reconstruction, Image quality
- Nuclear Medicine: Attenuation correction, Image reconstruction, Image quality
- Ultrasound: Beam patterns, Beam forming, Image formation
- MRI: k-space, Fourier Transform, Image reconstruction, Image quality
- Image processing: filtering, thresholding, segmentation

**Textbooks, Supplementary Materials, Hardware and Software Requirements**

**Required Textbooks/Resources**

• MATLAB Training: [https://matlabacademy.mathworks.com/](https://matlabacademy.mathworks.com/)
• Use Matlab LiveScript (freely accessible via UM account) for writing codes and submitting the solutions.

**Supplementary Materials**


**Hardware and Software Requirements**

The minimum requirements can be found at: [https://www.memphis.edu/uofmglobal/services/technology/requirements.php](https://www.memphis.edu/uofmglobal/services/technology/requirements.php)

**Assessment and Grading**

**Testing Procedures**

• Homeworks, assignments and projects should be submitted to appropriate dropbox, noting deadlines will not be extended.
• In-class quizzes involving solving problems by hand and/or Matlab and uploading to e-courseware dropbox.
• Exams can be closed book or open book and students should be prepared.
• Communication between students during the quizzes/exams is not allowed.

**Projects:**

Students will be assigned into teams and there will be ~3-4 students per team. Each team will give a 10-minute presentation on their project and submit a report during the final week of class. The choice of project topic is left to the student, but students must submit a short one-page proposal
of their project to the instructor by Wednesday, October 6th for approval. The project can be a discussion of a new imaging modality, a new development in a classical modality, a new clinical application, an in-depth review of the history of some modality, a detailed technical discussion of some aspect of a modality, a discussion of a clinical or research imaging problem and solutions, or another relevant topic which you find interesting. All students will be responsible for attending other teams’ oral presentations, ask questions and fill out a student score sheet form that will be counted towards their project grade. Graduate students will need to choose advanced level projects involving some development/design aspect.

**Grading Procedure**
Homeworks, quizzes, exams and projects will be scored and published on ecourseware.

**Grading Scale**

91-100---A
81-90---B
71-80---C
61-70---D

Final grade will be determined by dividing assignments into categories with the following weight toward the final grade.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes/Homeworks</td>
<td>20%</td>
</tr>
<tr>
<td>Participation</td>
<td>10%</td>
</tr>
<tr>
<td>Mid-term Exams</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Project</td>
<td>20%</td>
</tr>
</tbody>
</table>

**6000-level** students will be graded on a separate rubric that requires significantly advanced understanding as demonstrated in the assigned homework, quizzes, mid-term final exams and project reports.

**Class Participation**
Students must participate in all interactive aspects of the course. Students must check the course content and updates on ecourseware frequently for
announcements. Students must actively participate in threaded discussion events.

**Course Discussion - Piazza**
This class will have a Piazza site where we hope you all will ask and answer questions. It is common for several students to have the same questions about concepts, homework problems, etc., and the site (and app) gives the option to ask anonymously, to the instructors and/or the class as a whole. It should be a useful resource to aid everyone’s understanding of the content, and your participation on the site WILL be factored into the participation grade for the course.
(signup link: [https://piazza.com/memphis/fall2021/biom46901](https://piazza.com/memphis/fall2021/biom46901))

**Punctuality**
Students are expected to read announcements and communications from the professor in order to make progress through the course and turn in assignments in a timely manner.

**Course Ground Rules**
1. Students must use the assigned university e-mail address rather than a personal e-mail address.
2. Students are expected to learn how to navigate in D2L (ecourseware) and keep abreast of course announcements.
3. Students are responsible for all material, whether covered in class or as part of an assignment.
4. No late assignments (homework, reports) will be accepted. Late assignments will be assigned a score of zero, unless prior documentation and permission from the instructor has been approved.
5. Except when collaboration and teamwork is specifically encouraged or required, any work submitted for a grade must be your own original work. Working together on homework is certainly acceptable and encourage, but each person must work through the problem individually. Do not simply copy someone else’s solution. Do not electronically share your assignment files with classmates.
6. You are expected to participate actively in discussion.
7. Students are expected to communicate with other students on teams for laboratory assignments.
8. Absences from exams require prior documentation and approval from the instructor. Student is responsible for scheduling makeup exams.

9. You are responsible for determining the availability of computing resources used in the class and for scheduling work accordingly.

10. Students must always observe course netiquette.

11. You must fully comply with all university guidelines and applicable laws regarding the use of computing facilities and software that may be provided for this course.

12. Students should address technical problems immediately.

13. Academic dishonesty of any form will not be tolerated. See the “Code of Student Rights & Responsibilities” for further details.  
https://www.memphis.edu/osa/pdfs/csrr.pdf

14. Policies may be revised or augmented as required during the term.

Guidelines for Communication

Email
- Always include a subject line.
- Remember without facial expressions some comments may be taken the wrong way. Be careful in wording your emails. Use of emoticons might be helpful in some cases.
- Use standard fonts.
- Do not send large attachments without permission.
- Special formatting such as centering, audio messages, tables, html, etc. should be avoided unless necessary to complete an assignment or other communication.
- Respect the privacy of other class members.

Discussion Groups
- Review the discussion threads thoroughly before entering the discussion.
- Try to maintain threads by using the "Reply" button rather starting a new topic.
- Do not make insulting or inflammatory statements to other members of the discussion group. Be respectful of others' ideas.
- Be patient and read the comments of other group members thoroughly before entering your remarks.
- Be cooperative with group leaders in completing assigned tasks.
- Be positive and constructive in group discussions.
- Respond in a thoughtful and timely manner.
Plagiarism and Integrity
Plagiarism, cheating, and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly, through participation or assistance, are immediately responsible to notify the instructor of the class in addition to other possible disciplinary sanctions which may be imposed through the regular institutional disciplinary procedures. Expectations for academic integrity and student conduct are described in detail on the website of the Office of Student Accountability. Please read in particular, the section about "Academic Misconduct".

Turnitin.com
Your written work may be submitted to Turnitin.com, or a similar electronic detection method, for an evaluation of the originality of your ideas and proper use and attribution of sources. As part of this process, you may be required to submit electronic as well as hard copies of your written work or be given other instructions to follow. By taking this course, you agree that all assignments may undergo this review process and that the assignment may be included as a source document in Turnitin.com's restricted access database solely for the purpose of detecting plagiarism in such documents. Any assignment not submitted according to the procedures given by the instructor may be penalized or may not be accepted at all.

Library, Tutoring, and Other Resources
- The myMemphis Portal system, eCampus Student tab provides access to University library.
- The tutoring link in the course navigation bar provides access to free online tutoring through UpSwing tutoring.

Students with Disabilities
Qualified students with disabilities will be provided reasonable and necessary academic accommodations if determined eligible by disability services staff at the University of Memphis. Prior to granting disability accommodations in this course, the instructor must receive written verification of a student's eligibility for specific accommodations from the disability services staff. It is the student's responsibility to initiate contact
with Disability Resources for Students (DRS) and to follow the established procedures for having the accommodation notice sent to the instructor.

**Sexual Misconduct and Domestic Violence Policy**
This policy specifically addresses sexual misconduct which includes dating violence, domestic violence, sexual assault, and stalking. The policy establishes procedures for responding to Title IX-related allegations of sexual misconduct. Complaints can be reported to the Office for Institutional Equity (OIE). You may contact OIE by phone at 901.678.2713 or by email at oie@memphis.edu. Complaints can be submitted online at File a Complaint. OIE’s office is located at 156 Administration Building.

**Non-Discrimination and Anti-Harassment Policy**
University policy prohibiting discrimination and harassment based on protected characteristics and classes. Complaints of discrimination and harassment can be reported to the Office for Institutional Equity (OIE). You may contact OIE by phone at 901.678.2713 or by email at oie@memphis.edu. The full text of the policy can be found at GE2030 - Non-Discrimination and Antiharassment.

**Technology Requirements**
The following is a list of the minimum requirements to use our learning management system. Some courses will have more advanced requirements.
- Access to a reliable, high-speed Internet connection (DSL or Cable).
- Test your device to ensure it is compatible with our LMS (Learning Management System) using the System Check Wizard.
- Open PDF files using the free downloadable PDF software.
- Access Flash-based content with Adobe Flash Player (free).
- Use Microsoft Office for document creation (available for students via http://umapps.memphis.edu/)
- Play media content with Real Player (free), QuickTime (free), or Windows Media Player (free).

**Syllabus Changes**
The instructor reserves the right to make changes as necessary to this syllabus. If changes are necessitated during the term of the course, the instructor will immediately notify students of such changes both by
individual email communication and posting both notification and nature of change(s) on e-courseware.

**Technical Support**

Call the Helpdesk: 901-678-8888

[Online Helpdesk](#)