51:185 Physics and Analysis of Medical Images I

Syllabus for Spring Semester, AY2004-2005

Goals:

This course covers the physics of the major modalities commonly used in medical imaging. Also covered are the various principles and methods of constructing an image from the physical interactions of energy with living tissue, and the influence on image quality of the different modalities. Simple MATLAB programming will be required for some projects and assignments. Pre-requisites are a background in physics, computers, and biology, physiology, or anatomy.

This course is the second in a sequence of medical imaging courses offered in the Biomedical Engineering Department. The course sequence is 51:060 (Fall semester covering an introduction to medical imaging physics and analysis), followed by 51:185 (Spring semester covering a detailed description of the physics and image acquisition techniques of the primary medical imaging modalities), followed by 51:148 (Fall semester, cross-listed with 55:148, covering traditional image processing techniques), and then either 51:186 (Spring semester multidimensional medical image processing techniques) and/or 51:188 (Spring semester taught as an image practicum). Every two years we offer at least one advanced (200-level) course on contemporary topics in medical imaging.

Administration:

Instructor: E.L. Dove

Office: 1412 Seamans Center

Office Hours: MW 1:30-2:30 PM, and/or by appointment

Phone: 335-5635

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Lectures

MWF 9:30-10:20 AM; 4030 SC

Textbook:

Bushberg, J.T., J.A. Seibert, E.M. Leidholdt, and J.M. Boone. *The Essential Physics of Medical Imaging,* (2nd edition). Lippincott, Williams & Wilkins, Philadelphia, 2002. (ISBN 0-683-30118-7)

The textbook will be supplemented with class notes as needed.

General Topics (specific day-to-day topics in Table 1):

1. Brief review of the structure of the atom
2. X-ray physics
    a. Generation
    b. Interaction with matter
    c. Radiation protection
    d. Radiation dosimetry
    e. Fluoroscopy
    f. Mammography
    g. CT formation
3. Magnetic Imaging
    a. Resonance phenomenon
    b. MRI formation
    c. Function MRI
4. Ultrasound
    a. Basic principles
    b. A, B, M, C clinical modes
    c. Doppler
5. Nuclear Medicine
    a. Radiopharmaceuticals
    b. Detectors
    c. Emission Imaging
        i. PET
        ii. SPECT
6. Radiation protection, dose, and biology
    a. Principles of radiation oncology
    b. Brachytherapy

MATLAB will be used in some class presentations, projects, and assignments.

Examinations:

1. Mid-term Examination I - Tentative date: February 23, 2005
2. Mid-term Examination II – Tentative date: April 6, 2005
3. Final Examination: May 11, 2005 12:00 PM – 2:00 PM (Not comprehensive, room TBA)

Grades:

Unfortunately, I must assign a grade to each student. Assigned grades will be determined as follows:

1. Homework sets - 30%
2. Midterm examinations (2 exams, 15% each) - 30%
3. Quizzes, class participation – 10%
4. Final examination - 30%

From the Provost's Office:

This course is given by the College of Engineering. This means that class policies on matters such as requirements, grading, and sanctions for academic dishonesty are governed by the College of Engineering. Students wishing to add or drop this course after the official deadline must receive the approval of the Dean of the College of Engineering. Details of the University policy of cross enrollments may be found at the following URL: http://www.uiowa.edu/~provost/deos/crossenroll.doc

The University policy regarding academic dishonesty will apply to all projects, homework sets, and exams in this course.

Table 1 – Tentative day-to-day schedule for class, Spring 2005

Class	Date	Topic	Reading from Text
1	19-Jan	Introduction	Ch. 1
2	21-Jan	Radiation and the atom	Ch. 2
3	24-Jan	Generation of X-ray	Ch. 5 (Ch. 3 ref.)
4	26-Jan	X-ray interaction with matter	Ch. 3 & 5
5	28-Jan	Screen-film radiography; geometry	Ch. 3 & 5
6	31-Jan	Contrast, scattering	Ch. 6.7, 6.8
7	2-Feb	Radiation biology	Ch. 25
8	4-Feb	Radiation biology	Ch. 25
9	7-Feb	Radiation biology	Ch. 25
10	9-Feb	Mammography	Ch. 8
11	11-Feb	Fluoroscopy	Ch. 9
12	14-Feb	Fluoroscopy	Ch. 9
	16-Feb	No Class	
	18-Feb	No Class	
13	21-Feb	Image quality	Ch. 10
14	23-Feb	Image quality	Ch. 10
15	25-Feb	Examination I - through class 12	Open book & notes
16	28-Feb	Image quality	Ch. 10
17	2-Mar	ROC analysis	Ch. 10
18	4-Mar	Tomography	Ch. 12
19	7-Mar	Computed tomography	Ch. 13
20	9-Mar	Computed tomography	Ch. 13 & class notes
21	11-Mar	Computed tomography	Ch. 13 & class notes
22	21-Mar	Computed tomography	Ch. 13 & class notes
23	23-Mar	Nuclear Magnetic Resonance	Ch. 14
24	25-Mar	Nuclear Magnetic Resonance	Ch. 14
25	28-Mar	MRI	Ch. 15
26	30-Mar	MRI	Ch. 15
27	1-Apr	fMRI	Ch. 15 & notes
28	4-Apr	fMRI	Ch. 15 & notes
29	6-Apr	Ultrasound	Ch. 16
30	8-Apr	Examination II - through lecture 29	Closed book & notes
31	11-Apr	Ultrasound	Ch. 16
32	13-Apr	Ultrasound	Ch. 16
33	15-Apr	Ultrasound	Ch. 16
34	18-Apr	Radioactivity and Nuclear Transformations	Ch. 18
35	20-Apr	Radiopharmaceuticals and detection	Ch. 19 & 20
36	22-Apr	Radiopharmaceuticals and detection	Ch. 20
37	25-Apr	Nuclear imaging	Ch. 21
38	27-Apr	Nuclear imaging	Ch. 22
39	29-Apr	Nuclear imaging	Ch. 22
40	2-May	Radiation protection, dose, biology	Ch. 23
41	4-May	Radiation protection, dose, biology	Ch. 24
42	6-May	Review	
43	11-May	Final Examination	Closed book & notes
44&45		Visits to the Hospital Imaging Centers	