Engineering Faculty Document No. 57-16
March 19, 2018

TO: The Faculty of the College of Engineering

FROM: The Faculty of the Weldon School of Biomedical Engineering

RE: New Undergraduate Course, BME 43000, Introduction to Bioimaging

The Faculty of the Weldon School of Biomedical Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

BME 43000 Introduction to Bioimaging
Terms offered: Fall or Spring, Lecture 3, Cr. 3
Prerequisites: PHYS 24100 or PHYS 23400 or PHYS 27200

Description: Provides a conceptual framework for understanding the theory and technical principles behind major bioimaging modalities. The main focus is on basic principles and modes of imaging involving interactions of electromagnetic radiation with biological tissue. Main concepts include imaging and detection, modes of imaging modalities (e.g. reflection, transmission, absorption, and emission), and basic image characterizations. Applications include several critical biological and biomedical imaging methods, such as optical microscopy, ultrasound, X-ray imaging, computed tomography, positron emission tomography, and magnetic resonance imaging. Demonstrations of conventional bioimaging modalities are used to teach the topics.

Reason: Biomedical imaging and biological imaging play a key role in basic discoveries and diagnostic procedures. This course is aimed at students in science and engineering interested in gaining a conceptual and practical understanding of several critical biological and biomedical imaging methods. To validate novel biomedical technologies, to understand published results, and to communicate with medical communities, biomedical scientists and engineers need to have a solid understanding of the basic principles of major bioimaging modalities.

This course has been offered previously as a 400-level experimental course. Historically, many BME seniors have selected it as follows: Spring 2016 (18), Spring 2015 (33), Spring 2013 (27), and Spring 2012 (27). Primarily, driven by the relatively large undergraduate enrollment, the material covered and the pace of the course is appropriate for a 400-level course.

George R. Wodicka

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Weldon School of Biomedical Engineering

BME 43000 Introduction to Bioimaging
Syllabus

Prof. Young Kim
Office: MJIS 3027
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Office Hours: After each lecture or by appointment

Course Information
Spring semester, 2016
TR, 12:00 pm – 1:15 pm
MJIS 1083

Course Description

Biomedical imaging plays a key role in basic discoveries and diagnostic procedures. The main focus of this course is on basic principles and modes of major bioimaging modalities. This course will cover interactions of electromagnetic radiation with tissue, concepts in imaging and detection, modes of imaging modalities (e.g. reflection, transmission, absorption, and emission), and image characterization. Conventional bioimaging modalities will be used to teach the topics. This course will provide a conceptual framework for biomedical imaging in a reasonably concise and understandable format (with minimal mathematical approaches).

Course Goals

This course is particularly aimed at students in science and engineering interested in gaining a conceptual understanding of several critical biological and biomedical imaging methods, including optical microscopy, ultrasound, X-ray imaging, computed tomography, positron emission tomography, and magnetic resonance imaging.

Learning Objectives

By successfully completing this course, students will be able to:

1. Explain the principles of conventional bioimaging modalities.
2. Distinguish advantages and disadvantages of each modality.
3. Describe utilizations of imaging in biological and medical fields.
4. Determine appropriate bioimaging methods for particular studies and applications.

Class Schedule [Tentative]

- Week 1 - Course introduction and overview of bioimaging modalities
- Week 2 - Image characterization, basic electromagnetic radiation/wave, and interactions with tissue
- Week 3 - Interaction of X-ray with tissue
- Week 4 - X-ray imaging and computed tomography
- Week 5 - Introduction to nuclear medicine and radioactivity
- Week 6 - Emission imaging, emission tomography, and radiation safety
- Week 7 - Geometrical optics, aberration, and wave optics
- Week 8 - Optical microscopy I
- Week 9 - Optical microscopy II
- Week 10 - Spring break
- Week 11 - Introduction to magnetic resonance imaging

- Week 12 - Magnetic resonance imaging I
- Week 13 - Magnetic resonance imaging II
- Week 14 - Introduction to ultrasound imaging
- Week 15 - Ultrasound imaging
- Week 16 - Student final presentation and review

Required Textbook:

Suzanne A. Kane, Introduction to Physics in Modern Medicine, Taylor & Francis; 2nd edition, 2009.
http://www.haverford.edu/physics/course_materials/phys108b/textbook.htm#resources

Online Resources:

Blackboard will be used to communicate, track grades, post lectures, reading materials, assignments, etc.

Other Recommended Reading Books:

1. Bettyann H. Kevles, Naked To the Bone: Medical Imaging in the Twentieth Century, Basic Books, 1998.
2. Nadine B. Smith and Andrew Webb, Introduction to Medical Imaging: Physics, Engineering and Clinical Applications, Cambridge University Press; 1st edition, 2010.
3. Douglas B. Murphy, Fundamentals of Light Microscopy and Electronic Imaging, Wiley, 2001.

Other Electronic Resources:

1. Online Resources for Study, Review, Reference and Teaching Physics and Technology of Medical Imaging:
   http://www.sprawls.org/resources/#GENERAL MEDICAL IMAGING TOPICS
2. Introduction to Optical Microscopy, Digital Imaging, and Photomicrography:
   http://micro.magnet.fsu.edu/primer/index.html
3. Students will be given additional lists of reading materials.

Policies

Grade Assessment

25% - Class participation and assignment
35% - Midterm exam
35% - Final exam
5% - Project

Grading [Tentative]

Your total ≥ 90%:	A
80% ≤ your total < 90%:	B
70% ≤ your total < 80%:	C
60% ≤ your total < 70%:	D

Assignment

Each assignment will be evaluated critically; hence, students should be neat, careful, and above all comprehensive on the assignment. The assignment will include hands-on analyses of basic principles and concepts covered during lectures. This course use Matlab to conduct basic calculations and hands-on exercise. Students will have access to the package as well.

Examinations

There will be one midterm and one final exam scheduled during this course. These tests will be designed to assess students' knowledge of the conceptual framework of bioimaging. Each exam will contain workout problems, short answer, and essay questions.

Group Project

Two or three students will form a group for one group project. In brief, each group needs to select a hybrid imaging method and explain it in the framework of the basic principles covered in the course. Each group will present the project in the end of the course. More detailed guideline will be given.

Academic Dishonesty

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Attendance

Students are expected to be present for every meeting of the classes in which they are enrolled.

Students with Disabilities

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University. If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center of an impairment/condition that may require accommodations and/or classroom modifications.

Emergencies

1. Fire Alarm – Evacuate the building using the exits on the east side of RM 1053 (loading dock exit). Only gather personal items if it does not jeopardize your safety. Assist those

who need help, if possible. Proceed to the front lawn of the Burton Morgan Building. Report to a course instructor your name before leaving the emergency assembly area.
2. All hazards warning (examples of hazards: tornado (severe weather)/hazardous materials release/civil unrest/directed by police personnel) – When you hear the all hazards alarm immediately seek shelter. Continue to a safe location (typically the lowest level of the building in an area without windows).

Campus Emergency Policy
In the event of a campus wide emergency the class outline and course requirements may be subject to change. The course instructor will provide information in regards to changes in the course requirements or course schedule as a result of a campus wide emergency.

Nondiscrimination
Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, marital status, parental status, sexual orientation, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies.

This syllabus is subject to change.