

RADIOLOGY

Web Site: <http://www-radiology.stanford.edu>

Courses offered by the Department of Radiology are listed under the subject code RAD on the Stanford Bulletin's ExploreCourses web site.

The Department of Radiology does not offer degrees. However, its faculty teach courses open to medical students, graduate students, and undergraduates. The department also accepts students in other curricula as advisees for study and research. Undergraduates may also arrange individual research projects under the supervision of the department's faculty. This discipline focuses on the use of radiation, ultrasound, and magnetic resonance as diagnostic, therapeutic, and research tools. The fundamental and applied research within the department reflects this broad spectrum as it relates to anatomy, pathology, physiology, and interventional procedures. Original research and development of new clinical applications in medical imaging is supported within the Radiological Sciences Laboratory.

Faculty

Emeriti: (Professors) Herbert L. Abrams, Ronald Castellino, Barton Lane, Gerald Friedland, David A. Goodwin, Michael L. Goris, Henry H. Jones, William Marshall, I. Ross McDougall, Robert E. Mindelzun, Matilde Nino-Murcia, William H. Northway, Bruce R. Parker, Lewis Wexler, Leslie M. Zatz

Chair: Sanjiv Sam Gambhir

Professors: Patgrick Barnes, Richard A. Barth, Christopher F. Beaulieu, Bruce Daniel, Huy M. Do, Michael Federle, Nancy Fischbein, Dominik Fleischmann, Sanjiv Sam Gambhir, Gabriela Gayer, Gary H. Glover, Garry E. Gold, Robert J. Herfkens, Lawrence Hofmann, Dave Hovsepian, Debra M. Ikeda, R. Brooke Jeffrey, Peter Kane, Ralph Lachman, Barton Lane, Ann Leung, Craig Levin, Michael Marks, Tarik Massoud, Michael Moseley, Peter Moskowitz, Sandy Napel, Beverley Newman, Norbert J. Pelc, Allan Reiss, Brian Rutt, George Segall, F. Graham Sommer, Daniel Spielman, Daniel Y. Sze, Volney Van Dalsem, Joseph Wu

Professor (Research): R. Kim Butts-Pauly, Sylvia Plevritis

Associate Professors: Sandip Biswal, Francis Blankenberg, Francis P. Chan, Terry Desser, Andrei H. Iagaru, Nishita Kothary, William Kuo, David Larson, John Louie, Eric W. Olcott, Sunita Pal, Andrew Quon, Geoffrey Riley, Erika Rubesova, Kathryn J. Stevens, Shreyas Vasanawala, Juergen Willmann, Dorcas Yao, Greg Zaharchuk

Associate Professors (Research): Roland Bammer, Zhen Cheng, Heike Daldrop-Link, Rebecca Fahrig, Brian Hargreaves, Sylvia Plevritis, Jianghong Rao

Assistant Professors: Robert Dodd, Pejman Ghanouni, Howard Harvin, Gloria Hwang, Aya Kamaya, Sirisha Komakula, Jafi Lipson, Amelie Lutz, Payam Massaband, Erik Mittra, Zina Payman, Peter Poulos, Jianghong Rao, Daniel Rubin, Lisa Schmelzel, Rajesh Shah, Lewis Shin, Minal Vasanawala, David Wang, Joseph Wu, Kristen Yeom, Michael Zeineh, Ashwini, Zenooz

Assistant Professors (Research): Frederick T. Chin, Parag Mallick, Jennifer McNab, David Paik, Ramasamy Paulmurugan, Sharon Pitteri

Clinical Instructors: Bao Do, H. Henry Guo, Stefan Hura, Linda Morimoto

Courses

RAD 101. Readings in Radiology Research. 1-18 Unit.

Prerequisite: consent of instructor.

RAD 199. Undergraduate Research. 1-18 Unit.

Students undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

RAD 201SI. Introduction to Cardiac Image Processing Techniques. 1 Unit.

This course offers a unique opportunity for students to learn about the anatomy, function and physiology of the cardiovascular system by using advanced image processing technology based on CT and MRI. Students will learn to use different clinical software to visualize and interpret 3D and 4D images and to construct patient specific that can be used for surgical planning. Image data will be presented in the context of a clinical scenario, and student will learn about the cardiovascular anatomy and the pathogenesis of the disease being presented, while they practice image interpretation and model construction. The course will be held in the 3DQ Lab.

RAD 220. Introduction to Imaging and Image-based Human Anatomy. 3 Units.

Focus on learning the fundamentals of each imaging modality including X-ray Imaging, Ultrasound, CT, and MRI, to learn normal human anatomy and how it appears on medical images, to learn the relative strengths of the modalities, and to answer, "What am I looking at?" Course website: <http://bioe220.stanford.edu>.

Same as: BIOE 220

RAD 221. Physics and Engineering of Radionuclide-based Medical Imaging. 3 Units.

Physics, instrumentation, and algorithms for radionuclide-based medical imaging, with a focus on positron emission tomography (PET) and single photon emission computed tomography (SPECT). Topics include basic physics of photon emission from the body and detection, sensors, readout and data acquisition electronics, system design, strategies for tomographic image reconstruction, system calibration and data correction algorithms, methods of image quantification, and image quality assessment, and current developments in the field. Prerequisites: A year of university-level mathematics and physics.

Same as: BIOE 221

RAD 222. Instrumentation and Applications for Multi-modality Molecular Imaging of Living Subjects. 3-4 Units.

Focuses on instruments, algorithms and other technologies for imaging of cellular and molecular processes in living subjects. Introduces preclinical and clinical molecular imaging modalities, including strategies for molecular imaging using PET, SPECT, MRI, Ultrasound, Optics, and Photoacoustics. Covers basics of instrumentation physics, the origin and properties of the signal generation, and image data quantification. <http://med.stanford.edu/mips/education/bioe222/2016.html>.

Same as: BIOE 222

RAD 223. Physics and Engineering of X-Ray Computed Tomography. 3 Units.

CT scanning geometries, production of x-rays, interactions of x-rays with matter, 2D and 3D CT reconstruction, image presentation, image quality performance parameters, system components, image artifacts, radiation dose. Prerequisites: differential and integral calculus. Knowledge of Fourier transforms (EE261) recommended.

Same as: BIOE 223

RAD 224. Probes and Applications for Multi-modality Molecular Imaging of Living Subjects. 4 Units.

Focuses on molecular contrast agents (a.k.a. "probes") that interrogate and target specific cellular and molecular disease mechanisms. Covers the ideal characteristics of molecular probes and how to optimize their design for use as effective imaging reagents that enables readout of specific steps in biological pathways and reveal the nature of disease through noninvasive imaging assays. Prerequisites: none.

Same as: BIOE 224

RAD 225. Ultrasound Imaging and Therapeutic Applications. 3 Units.

Covers the basic concepts of ultrasound imaging including acoustic properties of biological tissues, transducer hardware, beam formation, and clinical imaging. Also includes the therapeutic applications of ultrasound including thermal and mechanical effects, visualization of the temperature and radiation force with MRI, tissue assessment with MRI and ultrasound, and ultrasound-enhanced drug delivery. Course website: <http://bioe225.stanford.edu>.

Same as: BIOE 225

RAD 226. In Vivo Magnetic Resonance Spectroscopy and Imaging. 3 Units.

Collections of identical independent nuclear spins are described by the classical vector model of magnetic resonance imaging (MRI); however, interactions among spins, as occur in many in vivo processes, require a more complete description. Physics and engineering principles of these in vivo magnetic resonance phenomena with emphasis on current research questions and clinical applications. Topics: product operator formalism, relaxation theory, and contrast mechanisms. Prerequisites: EE 369B or familiarity with magnetic resonance, working knowledge of linear algebra.

RAD 226A. In Vivo MR: SpinPhysics and Spectroscopy. 3 Units.

Collections of independent identical nuclear spins are well described by the classical vector model of magnetic resonance imaging, however, interaction among spins, as occur in many in vivo processes, require a more complete description. This course develops the basic physics and engineering principles of these interactions with emphasis on current research questions and clinical spectroscopy applications. Prerequisite: EE396b; familiarity with MRI, linear algebra recommended.

Same as: BIOE 326A

RAD 226B. In Vivo MR: Relaxation Theory and Contrast Mechanisms. 3 Units.

Principles of nuclear magnetic resonance relaxation theory as applicable to in vivo processes with an emphasis on medical imaging. Topics: physics and mathematics of relaxation, relaxation times in normal and diseased tissues, magnetization transfer contrast, chemical exchange saturation transfer, MRI contrast agents, and hyperpolarized ^{13}C .

Prerequisites: BIOE 22A.

Same as: BIOE 326B

RAD 227. Functional MRI Methods. 3 Units.

Basics of functional magnetic resonance neuroimaging, including data acquisition, analysis, and experimental design. Journal club sections. Cognitive neuroscience and clinical applications. Prerequisites: basic physics, mathematics; neuroscience recommended.

Same as: BIOPHYS 227

RAD 228. Magnetic Resonance Imaging Programming Topics. 3 Units.

Primarily for students working on research projects involving MRI pulse sequence programming. Introductory and student-initiated topics in seminars and hands-on labs. Image contrast mechanisms achieved by pulse sequences that control radiofrequency and gradient magnetic fields in real time, while acquiring data in an organized manner for image reconstruction. Prerequisites: EE 369B and consent of instructor.

RAD 229. MRI Sequences and Signals. 3 Units.

Magnetic Resonance Imaging (MRI) uses sequences of radiofrequency excitation and magnetic field gradients to generate a signal and form images. Numerous common and advanced sequences will be studied, including analysis techniques to predict signal and contrast levels, and to measure and reduce unwanted image artifacts. Prerequisite: EE 369B.

RAD 230. Ultrasound Instrumentation for Imaging and Therapy. 1-2 Unit.

This course teaches the physics, materials, modeling and processing steps involved in the design and fabrication of medical ultrasound transducers for diagnostic imaging and therapeutic applications. Students will learn how to consider various tradeoffs in the design and selection of clinical probes for particular uses, and a lab activity will reinforce the fundamentals of transducers and demonstrate how to assess probe performance in the real world.

RAD 235. Advanced Ultrasound Imaging. 3 Units.

The focus of this course is on advanced ultrasound imaging techniques for medical imaging applications. Topics include beamforming, adaptive beamforming, Fourier beamforming, synthetic aperture techniques, speckle, speckle reduction, k-space, harmonic imaging, coherence imaging, phase aberration, radiation force imaging, elastography, quantitative ultrasound, Doppler and flow imaging, ultrasounds modeling and advanced ultrasound theory.

RAD 260. Computational Methods for Biomedical Image Analysis and Interpretation. 3-4 Units.

The latest biological and medical imaging modalities and their applications in research and medicine. Focus is on computational analytic and interpretive approaches to optimize extraction and use of biological and clinical imaging data for diagnostic and therapeutic translational medical applications. Topics include major image databases, fundamental methods in image processing and quantitative extraction of image features, structured recording of image information including semantic features and ontologies, indexing, search and content-based image retrieval. Case studies include linking image data to genomic, phenotypic and clinical data, developing representations of image phenotypes for use in medical decision support and research applications and the role that biomedical imaging informatics plays in new questions in biomedical science. Includes a project. Enrollment for 3 units requires instructor consent. Prerequisites: programming ability at the level of CS 106A, familiarity with statistics, basic biology. Knowledge of Matlab highly recommended.

Same as: BIOMEDIN 260

RAD 280. Early Clinical Experience in Radiology. 1-2 Unit.

Provides an observational experience as determined by the instructor and student. Prerequisite: consent of instructor.

RAD 299. Directed Reading in Radiology. 1-18 Unit.

Prerequisite: consent of instructor.

RAD 370. Medical Scholars Research. 4-18 Units.

Provides an opportunity for student and faculty interaction, as well as academic credit and financial support, to medical students who undertake original research. Enrollment is limited to students with approved projects.

RAD 399. Graduate Research. 1-18 Unit.

Students undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.