APPLICATION FOR NEW COURSE

1. Submitted by the College of Medicine Date: January 16, 2009

Department/Division proposing course: Anatomy & Neurobiology

2. Proposed designation and Bulletin description of this course:

a. Prefix and Number ANA 655

b. Title* Introduction to Magnetic Resonance Imaging

*If title is longer than 24 characters, offer a sensible title of 24 characters or less: Intro MRI

c. Courses must be described by at least one of the categories below. Include number of actual contact hours per week..

(___) CLINICAL (___) COLLOQUIUM (___) DISCUSSION (___) LABORATORY (_x_) LECTURE

(___) INDEPEND. STUDY (___) PRACTICUM (___) RECITATION (___) RESEARCH (___) RESIDENCY

(___) SEMINAR (___) STUDIO (___) OTHER – Please explain: _____

d. Please choose a grading system: ☑ Letter (A, B, C, etc.) ☐ Pass/Fail

e. Number of credit hours: 3

f. Is this course repeatable? YES ☐ NO ☑ If YES, maximum number of credit hours: _____

g. Course description:

Survey of basic concepts and applications in magnetic resonance imaging: physics and chemistry, basic mathematical foundations, workings of a modern MRI scanner, image reconstruction, biology with emphasis on neurobiology, medical applications in the brain and heart. Covers basic functional imaging and spectroscopy.

h. Prerequisite(s), if any:

Undergraduate major in a science or engineering discipline.

i. Will this course also be offered through Distance Learning? YES ☐ NO ☑

If YES, please check one of the methods below that reflects how the majority of the course content will be delivered:

Internet/Web-based ☐ Interactive video ☐ Extended campus ☐

3. Supplementary teaching component: ☑ N/A or ☐ Community-Based Experience ☐ Service Learning ☐ Both

4. To be cross-listed as: _____ / _____

Prefix and Number — printed name / Cross-listing Department Chair — signature

5. Requested effective date (term/year): Fall / 2009

APPLICATION FOR NEW COURSE

6. Course to be offered (please check all that apply): ☑ Fall ☐ Spring ☐ Summer

7. Will the course be offered every year? ☐ YES ☑ NO

If NO, please explain: Alternates biennially with ANA 625: "Introduction to Functional Magnetic Resonance Imaging"

8. Why is this course needed?

There is no other course at UK which covers this increasingly important material.

9. **a.** By whom will the course be taught? Faculty of the Magnetic Resonance Imaging Center

b. Are facilities for teaching the course now available? ☑ YES ☐ NO

If NO, what plans have been made for providing them?

10. What yearly enrollment may be reasonably anticipated?

12 - 15

11. **a.** Will this course serve students primarily within the department? ☐ Yes ☑ No

b. Will it be of interest to a significant number of students outside the department? ☑ YES ☐ NO

If YES, please explain.

MRI is inherently interdisciplinary, with research and clinical applications in several basic science and applied science disciplines, e.g., mathematics, chemistry, physics, biology, computer science, medicine and engineering.

12. Will the course serve as a University Studies Program course†? ☐ YES ☑ NO

If YES, under what Area?

†AS OF SPRING 2007, THERE IS A MORTORIUM ON APPROVAL OF NEW COURSES FOR USP.

13. Check the category most applicable to this course:

☐ traditional – offered in corresponding departments at universities elsewhere

☑ relatively new – now being widely established

☐ not yet to be found in many (or any) other universities

14. Is this course applicable to the requirements for at least one degree or certificate at UK? ☑ Yes ☐ No

15. Is this course part of a proposed new program? ☐ YES ☑ NO

If YES, please name:

16. Will adding this course change the degree requirements for ANY program on campus? ☐ YES ☑ NO

If YES‡, list below the programs that will require this course:

‡In order to change the program(s), a program change form(s) must also be submitted.

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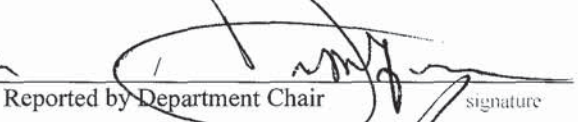
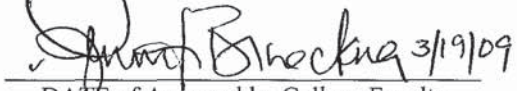
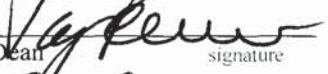
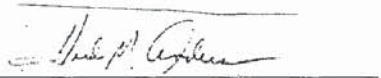
17. ☑ The major teaching objectives of the proposed course, syllabus and/or reference list to be used are attached.

18. ☐ Check box if course is 400G or 500. If the course is 400G- or 500-level, *you must include a syllabus showing differentiation* for undergraduate and graduate students by (i) requiring additional assignments by the graduate students; and/or (ii) the establishment of different grading criteria in the course for graduate students. (See *SR 3.1.4)*

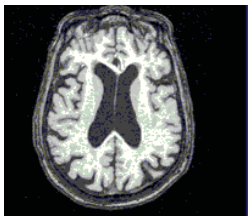
19. Within the department, who should be contacted for further information about the proposed new course?

Name: Charles D. Smith, MD Phone: 3-1113 Email: csmith@mri.uky.edu

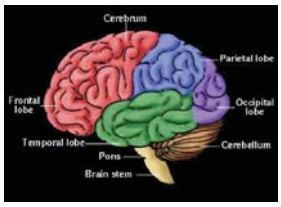
20. Signatures to report approvals:

Jan 30, 2009 DATE of Approval by Department Faculty	Doug Gash /  printed name Reported by Department Chair signature
 DATE of Approval by College Faculty	JAY A. PERMAN, MD /  printed name Reported by College Dean signature
2-16-09 * DATE of Approval by ~~Undergraduate~~ College of Medicine ~~Council~~ Curriculum Committee	C DARRELL JENNINGS, MD /  printed name Reported by Undergraduate Council Chair signature
* DATE of Approval by Graduate Council	Jeannine Blackwell 2010.01.06 09:10:37 -05'00' printed name Reported by Graduate Council Chair signature
4/21/09 * DATE of Approval by Health Care Colleges Council (HCCC)	Heidi Anderson /  printed name Reported by Health Care Colleges Council Chair signature
* DATE of Approval by Senate Council	Reported by Office of the Senate Council
* DATE of Approval by University Senate	Reported by Office of the Senate Council

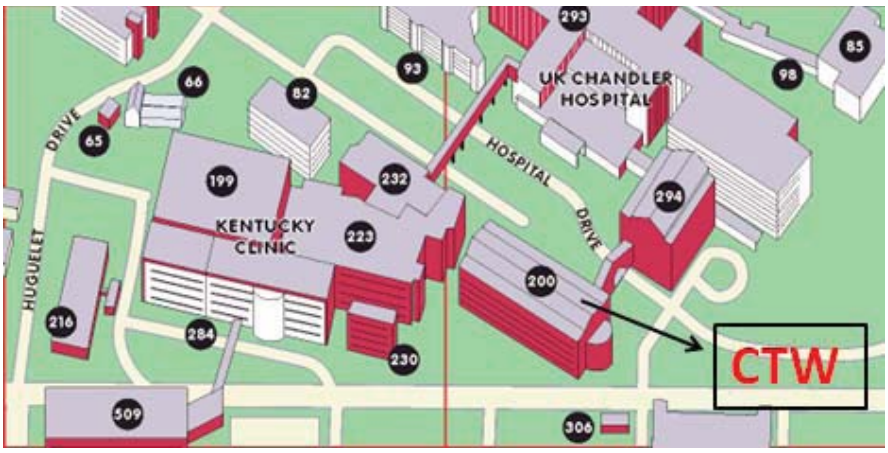
*If applicable, as provided by the *University Senate Rules*



MRI Course:



ANA 655 Introduction to Magnetic Resonance Imaging



Fall, 2009

Course Description: Introduces magnetic resonance (MR) imaging from the basic concepts to recent cutting-edge applications. Basic physics and chemistry of magnetic resonance; acquiring images using a scanner; fundamentals of image formation; processing MR images; interpreting images in terms of anatomy and physiology; MR spectroscopy; tracking neuronal fibers; functional MR imaging; cardiac and neurologic imaging. Students completing the course will have a basic knowledge of MR imaging fundamentals and applications.

Details: 30 - 1.5 hour meetings, 2 per week, 3 demonstration labs, 3 credits; Meets Tuesday/Thursday a.m. 9:00 – 10:15 starting August 27, 2009. Open to Graduate Students. Location: CTW 218 (building 200 in map above). Course Number: ANA 655

Contact: Dr. Charles Smith; csmith@mri.uky.edu, 323-1113.

Web Site: http://www.mc.uky.edu/mrisc

Fall 2009

Introduction to Magnetic Resonance Imaging
(Ana 655)

Faculty:

Course Director: Charles D. Smith, MD, Director, MRISC; Room 62, MRISC; csmith@mri.uky.edu; (CDS)
Lecturers:
Anders Andersen, PhD, Associate Professor, Department of Anatomy & Neurobiology; anders@mri.uky.edu; (AHA)
Peter Hardy, PhD, Assistant Professor, Biomedical Engineering; peter.hardy@uky.edu; (PAH)
David Powell, PhD, Adjunct Professor, Biomedical Engineering; dkpowe00@mri.uky.edu; (DKP)

Faculty Contact: To schedule faculty appointments, contact Nancy Baily, MRISC, 323-3973; bailey2@mri.uky.edu

Time and Place:

Tuesday, Thursday
Time: 9:00am – 10:30am
Place Charles T. Wethington, Jr. Building (CTW) 218

Prerequisites: Open to UK graduate students. An undergraduate major in a science discipline is required. Please contact the course director for exceptions.

A. Course Description (3 credits):

Introduces magnetic resonance (MR) imaging from the basic concepts to recent cutting-edge applications. Basic physics and chemistry of magnetic resonance; acquiring images using a scanner; fundamentals of image formation; processing MR images; interpreting images in terms of anatomy and physiology; MR spectroscopy; tracking neuronal fibers; functional MR imaging; cardiac and neurologic imaging. Students completing the course will have a basic knowledge of MR imaging fundamentals and applications to brain function, brain injury, disease, normal aging, etc.

Demonstrations: Three in-class demonstrations of MRI technology will be given to provide a real-life experience for the students. Demonstrations will take place in the Magnetic Resonance Imaging and Spectroscopy Center (MRISC) in the Whitney Hendrickson building, and the acquired images will be used in subsequent lectures.

Objectives: The objective of the course is to provide a solid foundation in magnetic resonance imaging for more advanced reading and for research work in the field.

B. Reading Material:

Text Book: MRI Principles, ***Second Edition***, D.G. Mitchell & M.S. Cohen, Saunders 2004. Further material may be provided by individual instructors and will consist of recent reviews and journal articles. Web resources: http.://www.cis.rit.edu/htbooks/mri/

C. Grading:

Examination and quiz grading will be on a percentile curve if the class distribution is below the expected normal, otherwise on an absolute percent scale. Presentations/reports will be rated on a 0 to 100 scale by the faculty.

Midterm exam 25%

The mid-term exam will be a series of best-choice multiple choice questions covering basic concepts, vocabulary and specific information delivered in the lectures and demonstrations in the first half of the course. The information needed to answer the questions will be covered in the lectures.

Final exam 25%

The final exam will be a series of best-choice multiple choice questions covering basic concepts, vocabulary and specific information delivered in the lectures and demonstrations over the whole course, but will emphasize new information from the second-half lectures and demonstrations. Reading the book or looking at the on-line slide sets alone may not provide enough information to get an "A" in the course, because lectures may cover areas not in these sources.

Weekly quizzes 25%

Weekly quizzes will be taken on line to cover the most important basic concepts and vocabulary related to that week's material.

Presentation/report 25%

A list of options will be provided for presentations or reports. Students are expected to choose one option for credit. Topics will include recent developments in MRI and research relevant to work being done at UK. Students will be given 15 minutes to present a PowerPoint report with 5 minutes allocated for discussion. Each student will be assigned to one of the instructors to provide guidance for their chosen topic.

Scoring for exams, quizzes, and presentations:

Scores	Grade	Basis
90-100	A	Answer fulfills most of what the instructor is looking for (additional points may be given for outstanding answers).
80-90	B	Answer correct in many respects, but could have been better.
70-80	C	Answers are flawed to some degree.
60-70	D	Answers are significantly flawed.
0-60	E	Did not turn in a serious effort.

D. Students Auditing:

Active participation in the course is essential for all students to achieve the course objectives. It is expected that every student, regardless of whether or not the course is taken for credit or a grade will actively participate in the course and discussions.

E. Attendance and Excused Absences:

Acceptable reasons for excused absences are listed in the Students Rights and Responsibilities. Students are entitled to an excused absence for the purpose of observing their major religious holidays. In the cases of excused absences, students will be given the opportunity to make up missed work or exams. However, the student must notify the course director prior to missed work or exams. Attendance at the three demonstrations is mandatory for the course; a penalty of 1 grade point will be assessed for each (unexcused) demonstration missed.

Attendance at all lectures is mandatory and will be recorded. A penalty of one half grade point will be assessed for each unexcused lecture missed.

F. Office Hours:

To schedule faculty appointments, contact faculty directly.

G. Course Outline:

Thurs 8/27/09 Course Introduction (CDS) - Details about course structure, expectations, grading, etc.
- a. MRI and other medical imaging technologies
- b. Role of medical imaging in health care
- c. Survey of applications of MR in biological research

Tues 9/1/09 Nuclear Magnetic Resonance Phenomena (CDS)
- a. The nuclear magnetic field
- b. Resonance concept
- c. Magnetic interaction, precession & the Lamor equation
- d. Magnitude and phase
- e. Basic spin interaction & resonance
- f. Bulk magnetization & Boltzmann distribution

Thurs 9/3/09 Relaxation (DKP)
- a. Local chemical / magnetic environment
- b. Spin-spin interaction & T2
- c. Lattice interaction & T1

Tues 9/8/09 Bloch equations and basic spectroscopy (DKP)

Thurs 9/10/09 Spatial Encoding (AHA)
- a. Gradient vs. static field
- b. Frequency encoding
- c. Phase encoding
- d. Slice selection

Tues 9/15/09 Basic Sequences (AHA)
- a. Basic spin echo pulse sequence.
- b. Pulse sequence diagram
- c. PD, T1, T2 sequence & examples

Thurs 9/17/09 Signal, Noise, Contrast and pulse sequence considerations, 2D and 3D (AHA)
- a. Signal strength equations.
- b. Sources of noise
- c. Intro to k-space and segmented acquisitions
- d. Echo planar acquisition

Tues 9/22/09 **Imaging Demonstration I**.
- a. tour of Trio MR Imager; identify parts
- b. imaging brain of volunteer with 2D, T1, PD, T2, three planes + oblique, 3D
- c. safety considerations

Thurs 9/24/09 Neuroimaging Cases I (CDS)
- a. T1 – cortical anomalies & malformations, hydrocephalus
- b. Contrast enhanced tumors
- c. T2 – Strokes, tumors, MS
- d. FLAIR - Multiple sclerosis
- e. Diffusion – tumor, stroke

Tues 9/29/09 Other Sources of Contrast & its Manipulation (PAH)
- a. Optimization of signal / contrast
- b. Magnetization transfer
- c. Contrast agents for image enhancement

Thurs 10/1/09 Cardiac imaging (Guest lecturer)

Tues 10/6/09 Flow effects (PAH)
- a. Motion of spins
- b. Flow compensation & encoding
- c. Flow artifacts
- d. MR angiography

Thurs 10/08/09 Perfusion (PAH)
- a. Dynamic contrast enhancement
- b. Applications in breast tumors & brain
- c. Arterial spin labeling
- d. Blood volume (VASO, etc)
- e. Cerebral Metabolic Rate of Oxygen consumption

Tues 10/13/09 ***Mid term exam***

Thurs 10/15/09 Diffusion (DKP)
- a. Physics of diffusion
- b. Diffusion tensor
- c. Fractional anisotropy

Tues 10/20/09 Applications of Diffusion (DKP)
- a. Correlation of FA with injury and development.
- b. Fiber tracking
- c. FA and fiber tracking applications – development, injury, anatomy, etc

Thurs 10/22/09 **Imaging Demonstration II.**
- a. DTI
- b. MRA
- c. MT
- d. ^{1}H spectroscopy

Tues 10/27/09 Basic Spectroscopy (DKP)
- a. Chemical shift Imaging
- b. Multinuclear
- c. Single vs. Multi-voxel encoding

d. STEAM

Thurs 10/29/09 Spectroscopy Applications (DKP)
- a. NAA, lactate
- b. Normal values
- c. Results – proton spectroscopy disease
- d. Results – multinuclear spectroscopy

Tues 11/3/09 Neuro Cases II. (CDS)
- a. Stroke examples shown on MRA, DTI, perfusion
- b. Neurosurgical cases with DTI abnormalities
- c. Aging? Epilepsy with NAA abnormalities
- d. MT and multiple sclerosis

Thurs 11/5/09 BOLD Contrast (AHA)
- a. Basic theory heme oxygenation
- b. Hemodynamic response
- c. GRE & SE EPI sequence
- d. Mapping example – visual cortex

Tues 11/10/09 fMRI Applications (AHA)
- a. Task designs – Block, event, runs, epochs
- b. Cognitive subtraction
- c. Vision, motor, hearing, faces - basic
- d. Language & higher-order functions – basic

Thurs 11/12/09 **Imaging Demonstration III**
- a. 3D T1-, T2-weighted for structural analysis
- b. fMRI acquisition

Tues 11/17/09 Image Processing 1: Functional (AHA)
- a. Time series
- b. Hemodynamic response correction
- c. Retrospective data pooling
- d. Statistical considerations

Thurs 11/19/09 Functional Neuroimaging Applications (Guest lecturer)

Tues 11/24/09 Image Processing 2: Structural (CDS)
- a. RF correction
- b. Registration
- c. Segmentation
- d. Filtering
- e. Normalization

Thurs 11/26/09 **Thanksgiving**

Tues 12/1/09 Structural Neuroimaging Applications (CDS)
- a. Changes in structure with disease and age

b. High-resolution structural mapping

Thurs 12/3/09 MR Safety (PAH)

Tues 12/8/09 Presentations of individual projects.

Thurs 12/10/09 Presentations of individual projects. Continued

Finals week Dec 14 - Dec18
Final Exam (given during Finals week)