New Course Request

Check Appropriate Boxes: Undergraduate credit [X] Graduate credit [ ] Professional credit [ ]

1. School/Division: Nursing and Health Professions

2. Academic Subject Code: AHLT

3. Course Number: R405 (must be cleared with University Enrollment Services)

4. Instructor: Medical Imaging Faculty

5. Course Title: Advanced Diagnostic Imaging I

Recommended Abbreviation (Optional) _______________________________

(Limited to 32 Characters including spaces)

6. First time this course is to be offered (Semester/Year): Fall 2009

7. Credit Hours: Fixed at ______ or Variable from _______ to _______

8. Is this course to be graded S-F (only)? Yes [X] No [ ]

9. Is variable title approval being requested? Yes [ ] No [X]

10. Course description (not to exceed 50 words) for Bulletin publication:
    Physics and imaging concepts in cardiovascular interventional technology, computed tomography, diagnostic medicalsonography and magnetic resonance imaging. Course will cover contrast media, instrumentation, equipment, principles of technology, as well as environmental and patient safety and comfort issues.

11. Lecture Contact Hours: Fixed at ______ or Variable from _______ to _______

12. Non-Lecture Contact Hours: Fixed at _______ or Variable from ________ to ________

13. Estimated enrollment: ______ of which ______ percent are expected to be graduate students.

14. Frequency of scheduling: Fall terms

15. Will this course be required for majors? Yes [X] No [ ]

16. Justification for new course: To allow BS/MSIT majors to complete didactic degree requirements

17. Are the necessary reading materials currently available in the appropriate library? Yes [X] No [ ]

18. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials. Attached

19. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant.

A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by: ______________________ Date: 4/15/09

Department Chairman/Division Director

Dean of Graduate School (when required)

Approved by: ______________________ Date: 4/17/09

Chancellor/Vice-President

University Enrollment Services

After School/Division approval, forward the last copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.

UPS 724

University Enrollment Services Final—White; Chancellor/Vice-President—Blue; School/Division—Yellow; Department/Division—Pink; University Enrollment Services Advance—White
Introduction
The following is a concise presentation of the above-named course. The student should retain this document for the duration of the program.

Course Description
Physics and imaging concepts in cardiovascular interventional technology, computed tomography, diagnostic medical sonography and magnetic resonance imaging. Course will cover contrast media, instrumentation, equipment, principles of technology, as well as environmental and patient safety and comfort issues.

Grading Procedure
Each examination will be given equal value in the consideration of your final grade and will make up 75% of that grade. The final exam will constitute the remaining 25%. All quizzes will be combined at the end of the session to equal one exam grade.

The grading scale will be as follows:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>A+</td>
</tr>
<tr>
<td>91 - 90</td>
<td>B+</td>
</tr>
<tr>
<td>82 - 90</td>
<td>C+</td>
</tr>
<tr>
<td>73 - 80</td>
<td>D+</td>
</tr>
<tr>
<td>64 - 72</td>
<td>F</td>
</tr>
</tbody>
</table>

PLEASE NOTE: A grade of less than C in this course will require the student to repeat the course during the next semester in which it is offered. If the student does not successfully complete this course the second time with a grade of C or better, they will be dismissed from the program. (See June 2008 Revision Radiography Student Handbook, page 22)
Withdrawal Policy:
Any other policies/procedures not addressed in this syllabus can be found in the IU South Bend Radiography program Student Handbook, page 23.

<table>
<thead>
<tr>
<th>Withdrawal Dates:</th>
<th>Automatic “W” Withdrawal Deadline</th>
<th>September 7-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawal with Grade of “W” or “F”</td>
<td>September 28-November 6</td>
<td></td>
</tr>
<tr>
<td>Last Day to Withdraw (5:00 p.m.)</td>
<td>November 6</td>
<td></td>
</tr>
</tbody>
</table>

*Withdrawal from any core professional radiography course will adversely affect the student’s enrollment in subsequence courses due to the nature of the program. Please to the radiography Student Handbook for details.

Objectives:
The student will be able to:

1. Identify the types of magnets used in MRI
2. Discuss the operation of those magnets learned
3. Distinguish the types and usage of the various coils used in MRI
4. Present the safety issues in the use of MRI equipment
5. Discuss the various parts of safety including patient safety in MRI
6. Discuss the scientific discovery of the principles of magnetic resonance (MR)
7. Discuss the development of MR imaging
8. Define common terms used in magnetic resonance
9. Describe the basic principles of magnetic resonance
10. Discuss the production and measurement of the NMR signal
11. Describe the concept of Fourier transformation of information
12. Define the basic MR terminology used routinely in the clinical setting
13. Explain the concept of variations in pulse sequences and parameters on the resultant image
14. Perform and define the Larmor equation
15. Describe the differences between T1 and T2 weighted imaging
16. Understand the mechanisms, components and be able to label the cross section of the various types of magnets
17. Discuss field strength
18. Discuss the purpose of gradients and cryogens in MR
19. Explain the orientation of the hydrogen atoms when placed in a magnetic field
20. Discuss the concept that a magnetic force acts perpendicular to the line of propagation of the radio frequency wave
21. Discuss the concept of frequency and its relationship to energy and wavelength
22. Describe the location of radio waves on the electromagnetic spectrum
23. Define angular magnetic moment, linear magnetic moment, magnetic vector, gradient magnetic field, spatial localization and dipole magnet
24. Explain the magnetic moment of a nucleus and what affects it most
25. Identify how a magnetic dipole is produced
26. Describe net magnetization and what determines net magnetization of an atom
27. Explain the effect of field strength on the energy and number of parallel and antiparallel protons
28. Define precession, magnetic wobble and the Larmor equation
29. Describe the factors that determine the precession of a spinning nucleus
30. Describe the relationship between resonant frequency, proton energy and the strength of the magnetic field
31. Discuss the importance of frequency and amplitude in relationship to MR spatial location
32. Describe the natural frequency
33. Discuss the principal of resonance
34. Explain the x, y and z axis and which designated the alignment of the static field
35. Describe how a magnetic force applied to one axis affects the net magnetization of the tissue
36. Discuss transmit and receive bandwidth and their importance of MR
37. Discuss spatial encoding in relation to magnetic resonance
38. Relate frequency and amplitude of an RF signal to spatial encoding
39. Discuss Faraday’s Law as it relates to the production of the MR signal
40. Explain the Fourier transformation
41. Differentiate between 2-D and 3-D imaging and reconstruction (2-DFT/3-DFT) methods
42. Describe how a 90 degree RF pulse (flip angle) is achieved
43. Describe how a 180 degree RF pulse (flip angle) is achieved
44. Describe relaxation time
45. Discuss the pulse sequence used to emphasize T2* contrast
46. Discuss repetition time (TR) and echo time (TE) that would yield each type of image
47. Explain free induction decay (FID)
48. Describe, compare and contrast spin-lattice (T1) relaxation, spin-spin (T2) relaxation and relative proton density (RPD) as to their definition, how they change in pathological conditions and how they change with the addition of contrast agents such as gadolinium
49. Explain the relaxation times for small molecules vs. large molecules
50. Describe all appropriate sequences used in MRI
51. Describe phase encoding and spin warp imaging
52. Describe usages and limitations of gradient echo and fast spin echo techniques
53. Compare and contrast spin echo and gradient echo imaging techniques
54. Describe the echo planar pulse sequence
55. Describe usages and limitations of echo planar pulse techniques
56. Differentiate between inversion time (T1), TE and TR
57. Explain the effect of TR and TE parameters on the image gray scale
58. Discuss the advantages and disadvantages of varying the TR and TE on the resultant image and on the total scan time
59. Describe the effects of flip angle, TR and TE on gradient echo imaging
60. Discuss the advantage of obtaining images at several TR and TE settings when studying a pathological condition
61. Discuss the effect of a very long TR time on the T1 information of the image
62. Identify the tissue parameters that affect tissue contrast
63. Identify the extraneous factors that can affect tissue contrast
64. Discuss the change in relaxation times caused by body composition and pathological conditions
65. Describe the effect temperature and poorly hydrated tissues have on the T1 of those tissues
66. Discuss the factors that affect contrast to noise (C/N) and signal to noise (S/N) and how changes to each factor affect the image and total scan time
67. Explain how T1-shortening contrast agents, such as gadolinium, affect the T1 and T2 of the tissues
68. Compare STIR (short tau inversion recovery) and chemical saturation techniques
69. Discuss gradient moment nulling and spatial presaturation techniques
70. Explain how blood flow produces alterations in contrast on the image
71. Explain the concepts of window and level in filming
72. Describe the differences in precessional frequencies of fat, water and silicone
73. Diagram pulse sequences to identify readout, phase and frequency components

Methodology:

- **Lectures:** lectures will be designed around the subject matter assigned. It is intended to amplify and clarify assigned material. The student shall have already read the text on the material to be covered PRIOR TO class.

- **Class Discussion:** good communication is of utmost importance in the learning process. We will stop and discuss any topic that needs to be readdressed for clarification at any time. Priority will be given to assigned material for that day.

- **A.V. Material:** it is imperative that a clear understanding of material is given. To aid in their process slides, DVD’s, whiteboard, transparencies, PowerPoint, and other material will used to enhance the learning process where needed. The use of web sites and computer-assisted learning will take place.

- **Individual Advising Sessions:** There is an open door policy. If you need assistance on anything, take advantage of this opportunity - please make an appointment to meet with me.

- **Testing:** each exam and quiz will be comprehensive. They may consist of short answers, true and false, essay, diagrams, matching and/or multiple choices. Because this is an imaging course, the majority of the exam will be labeling of images.

- **Lab Procedures:** None assigned for this course

- **Individual Presentation:** None assigned for this course
Accommodations:
If you require an accommodation, academic adjustment, or special service due to a disability, please inform the professor.

Attendance:
Attendance is mandatory and part of your semester grade. Those students absent from more than two classes will have their course grade lowered by one letter grade. Cases of documented absences due to health/personal reasons will be reviewed by the professor. It is the student's responsibility to contact the professor for make-up material following an absence.

Tardy Policy:
Students are expected to be punctual for class and clinical experience. A student will be considered tardy if they have not arrived within four (4) minutes of their scheduled start time.

Students are allowed two (2) tardies for each fall/spring semester. Any tardies beyond this total during the fall/spring semester will result in the assignment of clinical demerits with the possible probation, suspension or dismissal from the program. A repetitive pattern of tardies over successive fall/spring semesters or exceeding a total of six (6) for the academic year will result in the issuance of a Student Violation form with possible probation, suspension or dismissal from the program.

All time missed due to tardies, must be made up within five (5) clinical days of the occurrence. Failure to make up the time missed within the specified time period will result in the issuance of a student violation along with the possible probation, suspension or dismissal from the program.

CELL PHONE USAGE
Cell phones are to be adjusted to a non-audio mode prior to the start of class. Students who neglect to perform this action will be subject to disciplinary action as stated in the Indiana University South Bend Radiography Student Handbook (June 2008 revision), page 23, Item #11: Failure to Disengage the Audio Mode of a Cell Phone during Didactic Classes. In the event that a student has a valid need to be contacted during class, the instructor should be notified prior to class.

Learning Process:
This is the responsibility of both the professor and the student. It is the responsibility of the professor to present material in a concise manner utilizing all educational resources available. The student must first be familiar with the material as assigned (pre-class preparation), record the information the professor presents, relate it to the text, and combine them into an easily learned pattern. Once the pattern is set, the student reviews and studies until the material has been learned.

Another responsibility of the student is to maintain a prompt and consistent attendance record. Each and every hour of class is extremely important. Your learning process will be severely impaired if you are not there to acquire the notes from that class. When you do miss a class, it is your responsibility to find out what took place in that class and to obtain notes and assignments.

Remember, the learning process requires the cooperation of all of us. Help me to do my portion by asking questions if you do not understand the material. The only way I can tell if something is confusing or needs additional explanation is to hear from you. Use the open door policy to its fullest. I am always willing and most of the time available to help you understand material. If I am busy with someone else or cannot meet with you at that time, we will set up an appointment for a later date.

OUTLINE:
(For an in depth outline, consult the first page of each chapter of the text)

I. MRI Safety (Chapter 10, pg. 49-57 HB)
   A. Introduction
   B. The main magnetic field
   C. Projectiles
   D. Medical emergencies
   E. Implants and prostheses
   F. Pacemakers
   G. Gradient magnetic fields
   H. Ratio frequency fields
   I. Claustrophobia
   J. Quenching
K. Safety education (including contrast safety)
L. Patient monitoring
M. Monitors and devices in MRI
N. Site planning

II. Instrumentation and Equipment (Chapter 9)
   A. Introduction
   B. Magnetism
   C. Permanent magnets
   D. Electromagnets
   E. Superconducting electromagnets
   F. Fringe fields
   G. Shim coils
   H. Gradient coils
   I. Radio frequency coils
   J. The pulse control unit
   K. Patient transportation system
   L. Operator interface

III. Basic Principles (Chapter 1)
   A. Introduction and historical aspects of MRI
   B. Atomic structure
   C. Motion in the atom
   D. MR active nuclei
   E. The hydrogen nucleus
   F. Alignment
   G. Precession
   H. The Larmor equation
   I. Resonance
   J. The MR signal
   K. The free induction decay signal (FID)
   L. Relaxation
   M. T1 recovery
   N. T2 decay
   O. Pulse timing parameters

IV. Image Weighting and Contrast (Chapter 2)
   A. Introduction
   B. Image contrast
   C. Contrast mechanisms
   D. Relaxation in different tissues
   E. T1 contrast
   F. T2 contrast
   G. Proton density contrast
   H. Weighting
   I. T2* decay
   J. Pulse sequence

V. Encoding and Image Formation (Chapter 3)
   A. Introduction
   B. Gradients
   C. Slice selection
   D. Frequency encoding
   E. Phase encoding
   F. Sampling

VI. Data Collection and Image Formation (Chapter 3)
   A. Introduction
   B. Signal to noise ratio (SNR)
   C. Contrast to noise ratio (CNR)
   D. Spatial resolution
E. Scan time
F. Trade-offs
G. Decision making
H. Volume imaging

VII. Parameters and Trade-Offs (Chapter 4, pg. 15-21 HB)
   A. Introduction
   B. Signal to noise ratio (SNR)
   C. Contrast to noise ratio (CNR)
   D. Spatial resolution
   E. Scan time
   F. Trade-offs
   G. Decision making
   H. Volume imaging

VIII. Pulse Sequences (Chapter 5, pg. 22-33 HB)
   A. Introduction
   B. Spin echo pulse sequences
   C. Conventional spin echo
   D. Fast or turbo spin echo
   E. Inversion recovery
   F. Fast inversion recovery
   G. Gradient echo pulse sequences
   H. Conventional gradient echo
   I. The steady state echo formation
   J. Coherent gradient echo
   K. Incoherent gradient echo (spoiled)
   L. Steady state free precession (SSFP)
   M. Balanced gradient echo
   N. Fast gradient echo
   O. Echo planar imaging (EPI)
   P. Parallel imaging techniques