

## **WebCT Sample Course Syllabus**

<p><b>NMT 4213 NUCLEAR PHYSICS</b></p>
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**UNIVERSITY OF ARKANSAS FOR MEDICAL SCIENCES  
COLLEGE OF HEALTH RELATED PROFESSIONS  
DEPARTMENT OF NUCLEAR MEDICINE TECHNOLOGY**

**Credit Hours: 2  
Online Lecture Course  
Course Contact Hours: 25.3**

**Instructor:  
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## **1.0 General Information**

### **1.1 Catalog Description**

Presents concepts and physical properties governing the atom to include systems and units of measurement, atomic and nuclear structure, and particulate and electromagnetic radiation as they relate to nuclear medicine practices.

### **1.2 Course Rationale**

Atomic and nuclear physics is fundamental to the practice of nuclear medicine technology and is essential to understanding the sources, properties and safe practical applications of radiopharmaceuticals as well as the characteristics, capabilities, and limitations of nuclear medicine instrumentation. The effectiveness of a procedure and safety of both the patient and the staff is in direct proportion to the technologist's understanding and application of atomic and nuclear physics.

### **1.3 General Course Objectives**

Upon completion of this course, the student will be able to:

1. Accurately describe, both qualitatively and quantitatively, atomic and nuclear processes as they relate to the production of ionizing radiation.
2. Perform mathematical operations involving significant figures, scientific notations, exponential terms, and basic algebraic manipulations as they relate to radioactive decay, interaction, detection, and measurement of radioactive substances.
3. Accurately work with English, metric, and standard international units of measurement.
4. Communicate through speaking and writing the physical concepts and events using appropriate scientific terminology.

## **2.0 Instructional Methodology**

### **2.1 General Techniques**

The primary teaching technique is to use pre-recorded lecture modules (PowerPoint presentations which are narrated by the instructor). These will be available on-line via the UAMS WebCT site. In addition, there will be weekly group discussion sessions (either by group teleconferencing or discussion postings). These discussion sessions are scheduled to provide students with an opportunity to ask questions and interact in a real-time manner with the instructor. Students are expected to have viewed the assigned lectures prior to the discussion sessions and to actively participate by asking and answering questions during these sessions.

## 2.2 *Resource-Based Techniques*

Computer-aided self-study questions (self-tests) will be made available on WebCT to provide the student with sample questions that the student should be able to answer following completion of a lecture module. This will help focus the student toward the important points of the lectures. Links to other useful web sites will also be used to provide depth on subject matter when possible.

## 3.0 **Instructional Materials/Supplies**

On-line lecture materials, problem sets, and related materials will be available at the UAMS WebCT internet site. Students can print them out by going to the web site at <http://webct.uams.edu>. Documents (lecture handouts and problem sets) will be in Adobe Acrobat format. Students will need to have the [Acrobat Reader](#) installed on their computers to open the files. Each student who is enrolled in the class will be given access to the internet course.

## 3.1 *References—Print Materials*

### ***Required text:***

Physics in Nuclear Medicine, 3<sup>rd</sup> Edition by Simon R. Cherry, James Sorenson and Michael Phelps. Philadelphia: W B Saunders, 2003.

Nuclear Medicine and PET: Technology and Techniques, 5<sup>th</sup> Edition by Paul E. Christian, Donald R. Bernier and James K. Langan. St. Louis: Mosby, 2004.

Practical Mathematics in Nuclear Medicine Technology, Patricia Wells and Martha Pickett. Reston: Society of Nuclear Medicine, 1999.

### ***References:***

Principles and Practice of Nuclear Medicine, 2<sup>nd</sup> Edition by Paul Early and Bruce Sodee. St. Louis: Mosby-Year Book, Inc. 1995.

Nuclear Medicine Physics: The Basics, 5th Edition by Ramesh Chandra. New York: Lippincott Williams & Wilkins, 1998.

The Essential Physics of Medical Imaging, 2<sup>nd</sup> Edition, by Bushberg et al. New York: Lippincott Williams & Wilkins, 2002.

Physics in Nuclear Medicine by J.A. Sorenson and M.E. Phelps, 2<sup>nd</sup> Edition, 1987. (Out of Print)

Physics and Radiobiology of Nuclear Medicine by Gopal B. Saha, New York: Springer-Verlag, 2<sup>nd</sup> Edition, 2000.

Fundamentals of Nuclear Pharmacy, 4<sup>th</sup> Edition, by Gopal B. Saha, New York: Springer-Verlag, May 1998.

## **4.0 General Evaluation Procedure**

### **4.1 Student Evaluation Procedure**

A weighted average of graded problems, quizzes, and final test scores will determine the course grade.

Weighting is as follows:

Homework problems: 5%

Module Quizzes: 10%

Block Examinations: 85%

***All classroom coursework will be graded on a letter basis of A, B, C, D, or F, with grading scales outlined in course syllabi. The grading scale is a percentage based on the total number of points received and is as follows:***

A = 93% - 100%

B = 85% - 92%

C = 77% - 84%

D = 70% - 76%

F = Less than 70%

The students overall average and test average must be above 77% in order to receive a grade of "C" in the course.

Students whose overall average or test average falls below 77% will have to take a comprehensive final examination. This means that if a student has an overall average of 78% or higher and a test average of 76% or lower or an overall average of 76% or lower and a test average of 78% or higher, they will have to take a comprehensive final examination. Distance students taking the comprehensive final examination will do so in a Little Rock location on a date and time during Finals week to be determined.

The final examination will be counted the same weight as a regular examination and will be counted in the percentage weighting of the examination grade. The students overall average and test average will then be recalculated to include the comprehensive final examination. After recalculation, the students overall average and test average must be above 77% in order to receive a grade of "C" in the course.

Students that choose not to take the comprehensive final examination will receive a grade of no higher than a "D" in the course.

#### **4.2 *Instructor Evaluation Procedure***

Students will evaluate the instructor using the Instructor Evaluation Form which covers the areas of knowledge, organization, instructional skill, and enthusiasm. An evaluation of the course may also be completed by each student.

#### **4.3 *N/A***

#### **4.4 *Make-up and Retake Examinations***

##### ***Make-up Examination Policy***

Block examinations will be administered approximately every five weeks in the fall and spring semester and will be at proctored test sites. Block examination dates will be posted in the syllabus and/or WebCT. Make-up examinations are permitted only in the case of an emergency or illness. Documentation may be required regarding the illness or emergency before permission to take the examination is granted. If a student is to miss a block examination, it is the responsibility of the student to contact the instructor by phone and e-mail prior to the scheduled block examination time. Make-up examinations must be taken within seven calendar days after returning to clinic or class and will be scheduled at a time that is mutually agreed upon by the instructor and the student. It may be necessary for the student to take the make-up examination in Little Rock due to contractual obligations and assessed fees with the testing centers. Every effort should be made to take the examination at the regularly scheduled time.

##### ***Make-up Homework Assignment/Quiz Policy***

Online homework and quizzes are usually open for a set period of time and must be completed within the posted time frame. Make-up quizzes are permitted only in the case of an emergency, illness or computer problems. Documentation may be required regarding the illness or emergency before permission to take the examination is granted. If a make-up online homework or quiz is necessary, it is the responsibility of the student to contact the instructor by phone and e-mail prior to the expiration of the homework or quiz time. The make-up homework or quiz must be completed and submitted within 48 hours of resolving the emergency.

Other homework assignments must be completed by the posted date and time. Make-up homework is permitted only in the case of an emergency or illness. Documentation may be required regarding the illness or emergency before permission to take the examination is granted. If a homework assignment is to be turned in late for the above reasons, it is the responsibility of the student to contact the instructor by phone and e-mail prior to the homework due date. Make-up homework must be completed and submitted within 48 hours of resolving the emergency.

Quizzes or homework assignments completed late for reasons other than emergency or illness or computer problem will have a 10% per calendar day reduction in grade.

### ***Retake Examination Policy***

No retakes of examinations, homework, quizzes or other assignments are permitted

## **5.0 General Procedures**

The course will consist of online lecture modules accompanied by discussion sessions over the modules during class blocks. Each discussion session will generally consist of about 50 minutes of discussion and/or problem solving sessions. Students shall view online lecture modules prior to discussion sessions. Problems will be assigned to provide the student some practice. At the conclusion of each class block, an examination will be given and graded to check students' progress.

## **6.0 Class Attendance/Conduct/Dress Policy**

### ***6.1 General Remarks***

Students are expected to attend and participate in discussion sessions. Attendance will be taken at all weekly discussion sessions. Students should bring a calculator to the discussion sessions. Students should conduct themselves in a professional, respectful manner. Students who are disruptive may be dismissed from the discussion session.

### ***6.2 Session Absence Grading Effects***

Students are responsible for reading assignments and all material presented during a missed discussion session.

### ***6.3 Session Tardiness Grading Effects***

None

### ***6.4 Conduct/Dress***

There is no formal dress policy for this class.

## 7.0 Due Dates/Class Schedule

A class schedule, due dates for homework, and examination dates will be published on the WebCT course site [webct.uams.edu](http://webct.uams.edu).

## 8.0 Session Schedules

### 8.1 General Remarks

The course will be divided into 3 Class Blocks. Class Block #1 will consist of 4 one hour modules (1-4). Class Block #2 will consist of 4 one hour modules (5-8). Class Block #3 will consist of 2 one hour modules (9-10). Each module will be accompanied by a 50 minute real time discussion session. In addition there will be three 50 minute real time review sessions for the Class Block examinations. Three 90 minute examinations will be used to assess the progress of students. An examination will follow the completion of each class block. The date and time of each examination will be published on the WebCT course site.

### 8.2 Tentative Sessions Schedule

#### Class Block #1 (modules 1-4)

1. Review of basic physics quantities and units of measurement
  - Definitions and units of measurement of the fundamental physical entities.
  - Module 1 discussion session
2. Atomic *{extra-nuclear}* and Nuclear Structure
  - A review of atomic structure and the periodic table of the elements:
  - Nuclear structure and nomenclature
  - Isotones, isobars, and isomers
  - The even - odd rule
  - The neutron : proton ratio
  - Nuclear energy - the mass defect and nuclear binding energy
  - *Module 2 discussion session*
3. Nuclear transformations {radioactive decay processes}
  - Decay vs. de-excitation
  - Alpha decay
  - Beta minus decay
  - Beta plus decay
  - Isomeric transitions – prompt and delayed
  - Decay schemes

- *Module 3 discussion session*
4. Radioactivity—Law of Decay, Half Life, and Statistics
    - Disintegration rate as a function of the number of nuclei present
    - Radioactivity as a function of initial activity and time
    - Serial decay and the Bateman equation
    - Secular vs. transient equilibrium
    - *Module 4 discussion session*

**Class Block examination review session**

**Class Block #1 examination**

**Class Block #2 (modules 5-8)**

5. Radionuclide sources
  - Nuclear reactor products – fission products and neutron activated
  - Accelerator {*cyclotron*} products
  - *Module 5 discussion session*
6. Ionizing Radiation: Interactions with Matter
 

Part 1: Directly Ionizing

  - Definition of ionizing radiation
  - Types and sources of directly ionizing radiation
  - Linear energy transfer (LET)
  - The Bragg curve of charged particle interactions
  - The range of charged particle interaction
  - Positron interactions and annihilation radiation
  - *Module 6 discussion session*
7. Ionizing Radiation: Interactions with Matter
 

Part 2: Indirectly Ionizing

  - Definition of indirectly ionizing radiation
  - Properties of electromagnetic radiation
  - The electromagnetic spectrum and ionizing radiation
  - Photon interactions with matter
  - Coherent scatter ( $\sigma_{\text{coh}}$ )
  - Photoelectric effect ( $\tau$ )
  - Compton scatter ( $\sigma_s$  or  $\sigma_a$ )
  - Pair production ( $\pi$ )
  - *Module 7 discussion session*
8. Ionizing Radiation: Interactions with Matter
 

Part 3: Indirectly Ionizing

  - Attenuation and shielding

- Absorption and dosimetry
- Attenuation / absorption coefficients
- Total attenuation (absorption)  $\mu = \sigma_{\text{coh}} + \tau + \sigma + \pi$
- Mass vs. linear attenuation / absorption coefficient
- Mono-energetic photon attenuation / absorption –  

$$I_x = I_o e^{-\mu x}$$
- Half-value-layer (HVL)  $\{x = HVL \ \& \ [I_x / I_o] = 1/2\}$
- The inverse square law
- *Module 8 discussion session*

### **Class Block #2 examination review session**

### **Class Block #2 examination**

### **Class Block #3 (modules 9-10)**

#### 9. External {radionuclide} dosimetry

- The exposure rate constant {gamma constant} ( $\Gamma$ )
- Exposure (R) to dose (rad) conversion
- 0.869 rads / R in air
- f-factor for tissue
- Factors that determine total radiation dose (external)
- Source activity (A)
- Time (t)
- Distance (d)
- Shielding ( $e^{-\mu x}$ )
- External exposure calculations
- Without shielding  $R = A\Gamma t / d^2$
- With shielding  $R = (A\Gamma t / d^2) (e^{-\mu x})$
- *Module 9 discussion session*

#### 10. Internal {radiopharmaceutical} dosimetry

- Medical Internal Radiation Dose (MIRD) method of calculations
- Standardized units and tables
- The generalized equation(s)
- Parameter definitions and tabulated sources
- Accumulative activity determination ( $\tilde{A}$ ) in the source organ
- Physical, biological, and effective half-times
- $\tilde{A}_i = A_o f T_{\text{eff}}$  [accumulative activity in source organ (i)]
- The “S” factor for specific source-target organ sets
- Calculating organ doses for multiple source organs
- Standard dose tables and factors which modify their values.
- *Module 10 discussion session*

**Class Block #3 examination review session**  
**Class Block #3 examination**

**9.0 Instructional Staff**

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Office Hours: By appointment

**10.0 Policies**

**CHRP Copyright Policy and Disability Policy**

“The materials used in this course may include copyright protected materials provided for the personal educational use of the enrolled students and may not be further distributed.”

“The CHRP disability policy is available upon request.”

**While the provisions of this syllabus are as accurate and complete as possible, the instructor reserves the right to change any provision herein. Students will be notified of any changes and it is the responsibility of each student to know what changes, if any, have been made to the provisions of this syllabus and to successfully complete the requirements of this course.**