JEFFERSON COLLEGE
COURSE SYLLABUS

RAD160
Radiographic Physics
3 Credit Hours

Revised by: Janet E. Akers BS RT (R)(M)
Date: October 3, 2013

Kenny Wilson, Director, Health Occupation Programs Dena McCaffrey, Dean, Career & Technical Education
RAD160 Radiographic Physics

I. CATALOGUE DESCRIPTION

A. Prerequisites: Acceptance to Radiologic Technology Program, and reading proficiency.

B. Credit hour award: 3

C. Description: This course provides the student with the principles of x-ray generation and use, including the mathematical, electrical, chemical, and physical concepts necessary for x-ray production and beam characteristics. An introduction to the x-ray equipment, instrumentation and control, and the unit of measure is provided. An analysis of production and measurement of radiation, interaction with matter and film, the study of x-ray tubes, rating charts, and x-ray circuits will be presented. (F)

II. EXPECTED LEARNING OUTCOMES/CORRESPONDING ASSESSMENT MEASURES

<table>
<thead>
<tr>
<th>Expected Learning Outcomes</th>
<th>Assessment Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain the general principles of the Law of Conservation of Energy.</td>
<td>Class Discussion/Activity</td>
</tr>
<tr>
<td></td>
<td>Written Examinations</td>
</tr>
<tr>
<td></td>
<td>Written Assignments</td>
</tr>
<tr>
<td>Integrate the Bohr’s model of atomic structure with the chemical characteristics of a molecule.</td>
<td>Class Discussion/Activity</td>
</tr>
<tr>
<td></td>
<td>Written Examinations</td>
</tr>
<tr>
<td></td>
<td>Written Assignments</td>
</tr>
<tr>
<td>Integrate the principles and application of electrostatics, magnetism and electrodynamics.</td>
<td>Class Discussion/Activity</td>
</tr>
<tr>
<td></td>
<td>Written Examinations</td>
</tr>
<tr>
<td></td>
<td>Written Assignments</td>
</tr>
<tr>
<td>Compare single phase, three phase and high frequency generators in terms of radiation production and efficiency.</td>
<td>Class Discussion/Activity</td>
</tr>
<tr>
<td></td>
<td>Written Examinations</td>
</tr>
<tr>
<td></td>
<td>Written Assignments</td>
</tr>
<tr>
<td>Assess the design characteristics of the radiographic tube, housing and circuitry.</td>
<td>Class Discussion/Activity</td>
</tr>
<tr>
<td></td>
<td>Written Examinations</td>
</tr>
<tr>
<td></td>
<td>Written Assignments</td>
</tr>
<tr>
<td>Distinguish between photon and electron interactions with matter.</td>
<td>Class Discussion/Activity</td>
</tr>
<tr>
<td></td>
<td>Written Examinations</td>
</tr>
<tr>
<td></td>
<td>Written Assignments</td>
</tr>
</tbody>
</table>

III. OUTLINE OF TOPICS

A. Energy
   1. Physical Concepts of Energy
i. Force
ii. Work (force \times distance)
iii. Potential Energy
iv. Kinetic Energy

2. Law of Conservation of Energy
   i. Energy Levels
   ii. Forms of Energy
   iii. Transformation of Energy
   iv. E=mc^2

B. Structure of Matter
1. Subdivisions of Matter
   i. Mixture
   ii. Elements
   iii. Compounds
   iv. Atoms
   v. Molecules
2. Atomic Structures
   i. Electrons
   ii. Protons
   iii. Neutrons
3. The Elements
   i. Atomic and Mass Numbers
   ii. Isotopes
   iii. Periodic Table
   iv. Valence Number
4. Compound Bonding
   i. Ionic Bonds
   ii. Covalent Bonds
5. Ionization

C. Electrostatics
1. Electrification
   i. Positive and Negative Charges
   ii. Methods of Electrification
   iii. Conductors, Insulators and Semiconductors
2. Law of Electrostatics
3. Electroscope
4. Static Discharge

D. Electrodynamics – Direct Current Electricity
1. Sources of Electric Current
   i. Batteries – Cell
   ii. Generator – Dynamo
2. D.C. Circuits
   i. Potential Difference – Voltage
   ii. Current
   iii. Resistance
   iv. Ohm’s Law
   v. Components of a Basic Circuit
   vi. Ammeters and Voltmeters
   vii. Series Circuits
viii. Parallel Circuits
3. Electric Capacitor
4. Work and Power of a Direct Current Circuit

E. Magnetism
1. Classification of Magnets
   i. Natural magnets
   ii. Artificial Permanent Magnets
   iii. Electromagnets
2. Nature of Magnetism
   i. Laws of Magnetism
   ii. Magnetic domains
   iii. Magnetic Fields
   iv. Lines of Force
   v. Detection of Magnetism
3. Magnetic Classification of Matter
   i. Permeability
   ii. Retentivity
   iii. Ferromagnetic Materials
   iv. Paramagnetic Materials
   v. Nonmagnetic Materials
   vi. Diamagnetic Materials

F. Electromagnetism
1. Electromagnetism
   i. Phenomena – Hans Oersted and Davy
   ii. Solenoid
   iii. Electromagnet
   iv. Left Thumb Rule
2. Electromagnetic Induction
   i. Factors Affecting EMF (electromagnetic fields) Induction
   ii. Left Hand Rule
3. Self-Induction
   i. Counter – EMF
   ii. DC (direct current) Circuits
   iii. AC (alternating current) Circuits

G. Generators, Motors and Alternating Current
1. Electric Generator
   i. Construction
   ii. Generation of Current
2. Alternating Current
   i. Sine Curve
   ii. Root Mean Square
   iii. Ohm’s Law for AC Circuits
   iv. Advantages of AC
3. Electric Motor
   i. Motor Principle
   ii. Right Hand Rule
   iii. Synchronous Motors
   iv. Induction Motor
   v. Current Measuring Devices
1. Galvanometer
2. Electrodynamometer

H. Production and Control of High Voltage – Current Regulations
1. Transformers
   i. Mutual Induction
   ii. Transformer Law
   iii. Construction
      1. Step up, Step down, Isolation
      2. Air core, Open core, Closed core, Shell
   iv. Transformer Efficiency
      1. Efficiency Formula
      2. Power Losses

2. Auto Transformers
3. Control of Filament and Tube Current
   i. Choke Coil
   ii. Rheostat
   iii. Saturable Reactor

I. Rectification AC to DC
1. Methods
   i. Self-Rectification
   ii. Half Wave
   iii. Full Wave
   iv. Three Phase Rectification
2. Types of Rectifiers
   i. Vacuum Tube (Valve Tube)
   ii. Solid State Diode Rectification
3. Spinning Top Test
   i. Full wave Rectification
   ii. Timer Accuracy
   iii. Three Phase Rectification

J. X-Rays
1. Discovery
2. Electromagnetic Spectrum
   i. Frequency – Wavelength Relationship
   ii. Cosmic, Gamma, X, UV, Visible Light, IR rays
   iii. Quantum Theory – Photons
3. X-Ray Tube
   i. Component Parts
   ii. Crookes Tube
   iii. Coolidge Tube
4. X-Ray Production
   i. Conditions Necessary for Production
   ii. Electron Interactions
      1. Brems Radiation
      2. Characteristic Radiation
   iii. Target material
   iv. Efficiency of X-Ray Production
K. Property of X-Rays
L. X-Ray Beam Specifications
   1. Exposure (Quantity)
   2. Tube Current (mA)
   3. Tube Potential (kVp)
   4. Distance
   5. Filtration
   6. Quality
   7. Energy
      i. $E = hv$
      ii. Polyenergetic
      iii. Lambda Minimum
   8. Half Value Layer
   9. Spectral Distribution Curves
M. Interactions of X-Rays with Matter
   1. Attenuation – Absorption, Scatter, Distance
   2. Photon Energy
   3. Energy Levels and Electron Shells
   4. Photon Interactions
      i. Coherent (Unmodified) Scatter
      ii. Compton (Modifies) Scatter
      iii. Pair Production
      iv. Relative Importance of Various Interactions
N. X-Ray Dosimetry
   1. Linear Energy Transfer (LET)
   2. Exposure – Roentgen – R
   3. Absorbed Dose – Rad
O. X-Ray Tubes and Rectifiers
   1. Radiographic Tubes
      i. Cathode Assembly
      ii. Filament Thinning
      iii. Space Charge Compensation
      iv. Stationary Anodes
      v. Rotating Anodes
      vi. Anode Angle
   2. Factors Governing Tube Life
      i. Filament Factors
      ii. Anode Factors
      iii. Tube Charts
         1. Tube Rating Charts
         2. Cooling Curves
         3. Heat Units
P. X-Ray Circuits
   1. Equipment Design
      i. Source of Electricity – Line Voltage
      ii. Primary Circuit – Switch, Fuses, Line Voltage
         Compensator
      iii. Secondary Circuit – Step-up Transformer, mA Meter,
         Rectifiers, High Voltage Cable, X-ray Tube
iv. **Timing Devices**
   1. Mechanical Timers
   2. Synchronous Timers
   3. Old Electronic Impulse Timers
   4. Modern Electronic Timers
   5. mAs Timers
   6. Automatic Exposure Control
      a. Phototiming
      b. Ionization Chamber
v. **Filament Circuit**
vi. **Control Panel**
   2. Three Phase Generation of X-rays
   3. High Frequency Generators
   4. Mobile X-Ray Equipment
      i. Rechargeable Battery Powered
      ii. Capacitor Discharge Units
         1. Wave-tail Cutoff
         2. Grid Controlled Triodes
      iii. AC Wall Outlet Powered

IV. **METHOD(S) OF INSTRUCTION**

This course is taught using a variety of instructional methods, which include but are not limited to interactive lectures, computer presentations, group activities and exercises, videos, supplemental handouts and student presentations. Students are expected to be **ACTIVE** participants in the learning process. Students are expected to read the assigned readings prior to scheduled class meetings and come to class prepared to actively participate in all activities.

V. **REQUIRED TEXTBOOK(S)**


SUPPLEMENTAL TEXTBOOKS


VI. **REQUIRED MATERIALS**

A. A computer with internet access and basic software to include Word and Power Point (available through Jefferson College labs)
B. Course homepage available through Blackboard
C. Binder, paper, pens, pencils with erasers, highlighters
VII. SUPPLEMENTAL REFERENCES

A. Class Handouts
B. Library Resources
   1. Textbooks
   2. Periodicals
   3. Films On Demand Videos
C. Internet Resources
   1. On-line references
   2. Textbook companion website

VIII. METHOD OF EVALUATION (basis for determining course grade)

GRADES – Grades will be based on the percentage of total points earned out of total points possible for this semester. The assignments will vary in the number of possible points based upon amount of work involved and complexity of material. The student should be aware that proofreading and revision are extremely important when preparing homework. A final semester grade of 80% or above must be achieved in this course to successfully complete this course.

EXAMS – All exams with scores less than 75% must be retaken until a score of 75% or above is achieved to complete course requirements. The original score will be used to figure the semester grade. The student will be allowed to retake an exam a maximum of two times. If the student has not passed an exam within the three designated attempts, the student will present to the review board and may be dismissed from the program. The student must contact the instructor prior to any absence to make arrangements for retesting. Until course requirements are met, the final grade will be an incomplete.

If an exam is not taken at the scheduled time and arrangements for a make-up exam have not been made prior to the designated exam time, the grade for that exam will be zero. No make-up exam will be considered unless the instructor is personally notified prior to the absence. If a student arranges to take the exam at other than the scheduled time, 5% will be deducted from the grade on that exam. Make-up exams are scheduled at the convenience of the instructor.

Student’s grade will also be based on participation in class and attendance.

ASSIGNMENTS – In order to be prepared for each class meeting, the student should complete each homework assignment prior to the following class meeting. Assignments will consist of worksheets, textbook reading, review questions and other activities to enhance the learning experience.

Evaluation tools will include research projects, written and oral communication projects, class attendance/participation, homework assignments, and exams.

All assignments must be typewritten and are due at the beginning of class on the
assigned due dates. Late assignments will not be accepted. In-class quizzes and assignments cannot be made up.

Grading Scale: *(Jefferson College Radiologic Technology Program’s)*

- A= 100-92%
- B= 91.9-86%
- C= 85.9-80%
- D= 79.9-70%
- F= 69.9 and below
- I= Incomplete
- W= Excused withdrawal from course

IX. ADA AA STATEMENT

Any student requiring special accommodations should inform the instructor and the Coordinator of Disability Support Services (Library; phone 636-481-3169).

X. ACADEMIC HONESTY STATEMENT

All students are responsible for complying with campus policies as stated in the Student Handbook (see College website, [http://www.jeffco.edu](http://www.jeffco.edu)).

XI. ATTENDANCE STATEMENT

Students earn their financial aid by regularly attending and actively participating in their coursework. If a student does not actively participate, he/she may have to return financial aid funds. Consult the College Catalog or a Student Financial Services representative for more details. Student’s grade will also be based on participation in class and attendance.

XII. OUTSIDE OF CLASS ACADEMICALLY-RELATED ACTIVITIES

The US Department of Education mandates that students be made aware of expectations regarding coursework to be completed outside the classroom. Students are expected to spend substantial time outside of class meetings engaging in academically-related activities such as reading, studying, and completing assignments. Specifically, time spent on academically-related activities outside of class combined with time spent in class meetings is expected to be a minimum of 37.5 hours over the duration of the term for each credit hour.