rev 10/10

CHATTANOOGA STATE COMMUNITY COLLEGE
CHATTANOOGA, TENNESSEE
NURSING/ALLIED HEALTH DIVISION

RADIATION THERAPY TECHNOLOGY PROGRAM

COURSE SYLLABUS

HS 214 RADIATION PHYSICS I

INSTRUCTORS: Lisa Legg — Shane West
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SEMESTER: fall **CREDIT HOURS: 4** **CLASS HOURS: 4** **LAB HOURS: 0**
DATES: EVERY OTHER THURSDAY AND FRIDAY **TIME: TBA** **LOCATION: OMNI 175**

COURSE DESCRIPTION: A course designed to cover the basic classic and modern physics concepts required for a thorough knowledge of the physics involved in radiation therapy. Mathematical concepts required for the physics principles are also covered.

PREREQUISITE: Acceptance into the Radiation Therapy Technology program.

COREQUISITES: HS 123, HS 172, HS 220.

REQUIRED (R)TEXTBOOK(S) AND SUGGESTED (S) REFERENCE MATERIAL BASIC TO COURSE:

1. The Physics of Radiation Therapy. Khan, Faiz M., Williams and Wilkins, 2003. (R)
2. Math Skills for Allied Health Careers. Timmons, Daniel, L. & Johnson, Catherine, W., Pearson Prentice Hall, 2008. (R)
3. A Primer on Theory and Operation of Linear Accelerators in Radiation Therapy. Karzmark, C. J. and Morton, Robert, 1981. (S)

CLASS SCHEDULE: See 'Program Schedule' for specific class dates.

PROGRAM LEARNING OUTCOMES (PSLOs): This program and its curricula are designed to prepare the graduates to attain and master the knowledge, skills, and affect needed to enter the field of radiation therapy. The following goals:

PSLO1: Prepare graduates to possess the knowledge, skill, and affect to meet the demands of an entry-level position in radiation therapy technology by ensuring that graduates:

(a) demonstrate clinical competence appropriate for an entry-level radiation therapist;
(b) demonstrate satisfactory oral and written communication skills;
(c) demonstrate satisfactory critical thinking/problem solving skills; and
(d) demonstrate an understanding of the importance of professional development and lifelong learning.

PSLO2: Provide the regional medical community with qualified individuals who can function as competent entry-level radiation therapists by ensuring that graduates:

(a) complete the program in a timely manner;
(b) pass the American Registry of Radiologic Technologists certification examination;
(c) receive jobs upon graduation;
(d) are satisfied with the education they received from the program; and
(e) meet the expectations of employers.

COURSE COMPETENCIES: The student will demonstrate the required level of performance Relative to the following areas:

CSLO-A: Demonstrate thorough knowledge of mathematical concepts pertaining to radiation therapy. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -B: Demonstrate knowledge of the basic structure of matter. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -C: Differentiate between particulate and non-particulate radiation. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -D: Demonstrate knowledge of activity, radioactivity, and decay. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -E: Identify the units used to measure radioactivity and radiation. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -F: Demonstrate knowledge of the production of x-rays. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -G: Recall the important figures and events in the production of x-rays and the development of radiation therapy. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -H: Demonstrate basic understanding on the operation of a linear accelerator. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -I: Identify the origin, production, and properties of various machines which produce radiation. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -J: Demonstrate an understanding of basic radiation interactions. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

CSLO -K: Appreciate the differences between radiation quantity and radiation quality. (PSLO1a, PSLO1b, PSLO1c, PSLO2b)

TOPIC SCHEDULE / COURSE CONTENT / INSTRUCTIONAL COMPETENCIES:

Meeting / Unit / Topic

1-2 / 1 /Orientation/Mathematical Review

3-4 / 1 / Mathematical Review (CSLO-A)

I. Algebraic Expressions
   - A. Fundamental operations
   - B. Order of operations
   - C. Powers and roots
   - D. Laws of exponents
   - E. Radicals and fractional exponents
   - F. Simplifying by combining like terms
   - G. Substitution in formulas
   - H. Scientific notation
   - I. Metric system
   - J. Dimensional analysis

II. Solving Problems Using Algebra
   - A. One variable equations
   - B. Word problems
   - C. Percentage problems

III. Geometry
   - A. Lines
   - B. Angles
   - C. Plane figures
   - D. Perimeter
   - E. Area

IV. Statistics
   - A. Steps for solving a statistics problem
   - B. Analysis of data
   - C. Frequency tables
   - D. Charts and graphs
   - E. Measures of center
   - F. Mean
   - G. Standard deviation

V. Logarithms and Exponents
   - A. Log
   - B. Ln

Instructional Indicators: Mathematical Review (CSLO -A)

The student will:

1. Perform fundamental operations of basic mathematics.
2. Recall and properly apply the principles relating to the 'order of operations' when solving mathematical problems.
3. Use the law of exponents to simplify mathematical expressions.
4. Perform mathematical operations containing radicals.
5. Simplify mathematical equations by combining like terms.

6. Given a formula and numerical values for the variables, solve the equation.
7. Correctly convert numbers into scientific notation.
8. Correctly convert metric measurements.
9. Understand and properly apply the concept of dimensional analysis when solving mathematical problems.
10. Solve simple algebraic equations.
11. Given a word problem, formulate and equation and solve for the unknown variable.
12. Correctly convert fractions to decimals and decimals to fractions.
13. Correctly fractions and decimal to percentages.
14. Calculate the perimeter of a triangle, square, rectangle, and circle.
15. Calculate the area of triangle, square, rectangle, and circle.
16. Calculate the volume of a triangle, square, rectangle, and circle.

5/Unit 2/Structure of Matter (CSLO -B, CSLO -C)

Reading Assignment:

Khan: Chapter 1

I. Review of atomic structure
- A. Matter
  - 1. Elements
  - 2. Compounds
  - 3. Mixtures
- B. Force
- C. Energy
  - 1. Kinetic energy
  - 2. Potential energy
- D. Atoms
  - 1. Periodic Table
    - a. rows
    - b. columns
  - 2. Nucleus
    - a. atomic number
    - b. unit charge
    - c. mass number
    - d. categories
      - --isotopes
      - --isotones
      - --isobars
      - --isomers
  - 3. Subatomic particles
    - a. protons
    - b. neutrons
    - c. electrons
  - 4. Atomic mass and energy units
  - 5. Distribution of orbital electrons
    - a. maximum orbital numbers

b. binding energy
6. Atomic energy levels
7. Nuclear forces
8. Nuclear energy levels

E. Atomic Nomenclature
1. Atomic number
2. Mass number
3. Symbolic representation

F. Fundamental forces
1. Strong
2. Electromagnetic
3. Weak
4. Gravitational

II. Particulate radiation
A. Types
B. Characteristics

III. Electromagnetic radiation
A. Types
1. Ionizing vs. non-ionizing
2. Particulate vs. non-particulate
B. Spectrum
C. Wave model
1. wavelength
2. frequency
D. Quantum model
E. Relative equations
1. $E=mc^2$
2. $C=\lambda v$
3. $E=h\lambda$
4. $E = ½ mv^2$

Instructional Indicators: Structure of Matter (CSLO-B, CSLO-C)

The student will:

1. Compare and contrast the terms matter, force, and energy.
2. Describe how mass and acceleration relate to force.
3. Differentiate between kinetic energy and potential energy.
4. Given the appropriate information, calculate kinetic energy and/or potential energy.
5. Describe the structure of an atom.
6. Given a periodic table, identify an element by group and symbol.
7. Given a periodic table, identify the atomic number and atomic mass of any element.
8. Demonstrate a knowledge of atomic nomenclature.
9. Compare and contrast the terms iostope, iostone, iosbar, and isomer.
10. Describe the subatomic particles based on their characteristics.
11. Given an element, diagram its distribution of orbital electrons.
12. Define binding energy.
13. Discuss the atomic energy levels.
14. Discuss nuclear forces and nuclear energy levels.
15. Describe the characteristics of particulate radiation.

16. Give examples of particulate radiation.
17. Differentiate between ionizing and non-ionizing electromagnetic radiation.
18. Discuss the 'wave model' of electromagnetic radiation as it relates to wavelength and frequency.
19. Discuss the relationship between wavelength and frequency.
20. Calculate wavelength and/or frequency when given the appropriate information.

6/Unit 3/Nuclear Transformations (CSLO-A, CSLO-D, CSLO-E)

Reading Assignment:

Khan: Chapter 2

I. Radioactivity
II. Decay constant
III. Activity
  A. Definition
  B. Environmental influence
  C. Formula
  D. Units

IV. Half life
  A. Definition
  B. Relationship to decay constant
  C. Specific values
V. Mean half life
  A. Definition
  B. Relationship to half life
VI. Radioactive series

VII. Radioactive equilibrium
  A. Transient
  B. Secular
VIII. Modes of radioactive decay
  A. Line of stability
  B. Decay schemes
  C. Primary modes
    1. Alpha (α) particle decay
    2. Beta (β) particle decay
    3. Electron capture
  D. Secondary modes
    1. Gamma (γ)
    2. Internal conversion
IX. Calculations
  A. Decay equation
  B. Problem solving
X. Nuclear reactions
  A. Alpha bombardment
  B. Proton bombardment
  C. Deuteron bombardment

D. Neutron bombardment
E. Photodisentegration
F. Fission
G. Fusion

XI. Activation of Nuclides
XII. Nuclear Reactors

Instructional Indicators: Nuclear Transformations (CSLO-A, CSLO-D, CSLO-E)
The student will:

1. Define radioactivity, decay constant, and activity.
2. Discuss the influence that the environment has on activity.
3. Recall the units used to measure activity.
4. Compare and contrast half life and mean half life.
5. Define radioactive equilibrium.
6. Briefly describe the following modes of radioactive decay: alpha, beta, electron capture, gamma, and internal conversion.
7. Given the appropriate information, calculate the rate of decay of a radioactive material.
8. Discuss the reactions that occur during alpha, proton, dueteron, and neutron bombardment.
9. Define photodisentegration.
10. Compare and contrast fission and fusion.
11. Describe how elements are made radioactive.
12. Briefly describe the operation and purpose of a nuclear reactor.

7 / -- / Exam 1 Math…Math Notebook Due

8 / Unit 4 / Production of X-rays (CSLO-F, CSLO-G)

Reading Assignment:
Khan: Chapter 3

I. Sources of radiation
A. Natural
B. Man-made
II. The discovery of x-rays
A. W. Roentgen
B. Method of discovery
C. Other important figures
1. William Crookes
2. A. H. Becquerel
3. Marie and Pierre Curie
D. Historical Perspective
1. Early years (1800)
2. Golden age (1900)
3. Nuclear age (1950)
4. New Millenium (2000-)

E. Early uses of x-rays
1. Diagnosis
2. Therapy
3. Industry

III. The x-ray tube
A.. Anode
B. Cathode
C. Target
1. reflective
2. transmission
D. Tube housing
E. Thermal capacity

IV. Basic x-ray circuitry
A. Primary Circuit
B. Secondary Circuit

V. Voltage rectification

VI. X-ray production
A. Processes
1. Bremsstralung
2. Characteristic
B. Necessary Conditions
C. Factors Affecting Output
1. Tube potential
2. Tube current
3. Filament current
4. Time
5. Distance
6. Filtration

VII. X-ray Energy Spectra
A. Unfiltered
B. Filtered
1. inherent
2. added
C. Throreus filter

VIII. Operating characteristics
A. Filament current
B. Output

Instructional Indicators: Production of X-rays (CSLO-F, CSLO-G)

The student will:

1. Discuss the two main sources of radiation and give examples of each.
2. Discuss the discovery of x-rays.
3. State the significant accomplishment of Roentgen, Crookes, Becquerels, and the Curies.
4. Recall the early uses of x-rays.
5. Describe the basic construction of an x-ray tube.
6. Compare and contrast a reflective and transmission target.
7. Describe the basic construction of an x-ray circuit.

8. Discuss the differences between the production of bremsstrahlung and characteristic radiation.
9. Discuss how filtration affects the spectra of a radiation beam.
10. Differentiate between inherent and added filtration.
11. Discuss the composition of a thoreus filter.
12. Discuss the filament current and output of an x-ray tube.

9-10 / Unit 5 / Clinical Radiation Generators & Simulators (CSLO-H, CSLO-I)

Reading Assignment:

Khan: Chapter 4

Karzmark: Linear Accelerator Primer

I. Kilovoltage units
- A. Grenz ray therapy
  1. energy range
  2. beam characteristics
     a. maximum dose depth (D_{max})
     b. depth dose
- B. Contact therapy
  1. energy range
  2. tube current
  3. treatment distance
  4. filtration
  5. beam characteristics
     a. maximum dose depth (D_{max})
     b. depth dose
- C. Superficial therapy
  1. energy range
  2. tube current
  3. reflection target
  4. treatment distance
  5. typical HVL
  6. beam characteristics
     a. maximum dose depth (D_{max})
     b. depth dose
- D. Orthovoltage
  1. energy range
  2. tube current
  3. reflection target
  4. treatment distance
  5. typical filtration
  6. typical HVL
  7. beam characteristics
     a. maximum dose depth (D_{max})
     b. depth dose
- E. Supervoltage
  1. energy range

F. Van de Graff Generator
    1. basic design
    2. energy range
    3. electrical insulation
    4. transmission target

II. Disadvantages of Low Energy Machines
- A. Penumbra
- B. Output
- C. Dose profiles
- D. Penetration
- E. Skin dose
- F. Clinical limitations

III. Linear Accelerator
- A. Components
    1. External components
        - a. gantry
        - b. stand
        - c. treatment head
        - d. power supply
        - e. modulator
    2. Internal components
        - a. electron gun
        - b. RF driver
        - c. magnetron/klystron
        - d. waveguide
        - e. circulator
        - f. dummy load
        - g. accelerator guide
        - h. bending magnet
        - i. transmission target
        - j. primary collimators
        - k. flattening filter/scattering foil
        - l. ionization chambers
        - m. light source
        - n. mirror
        - o. variable collimators
        - p. auxillary systems
            - i. vacuum
            - ii. pressure
            - iii. cooling
            - iv. automatic frequency control
- B. Basic operation
    1. photon production
    2. electron production
- C. Filtration
- D. Auxillary equipment
- E. Quality Assurance
- F. Room shielding

- G. Patient observation
- H. Emergency considerations

IV. Cobalt 60 Unit
- A. Components
- B. Source
  1. Production
  2. Size
  3. Half-life
  4. Decay Scheme
  5. Energy spectrum
  6. Penumbra
- C. Auxillary Equipment
- D. Method of Operation
- E. Quality Assurance
  1. Room shielding
  2. Personnel monitoring
- F. Patient observation
- G. Emergency considerations

V. Other High Energy Machines
- A. Betatron
  1. basic design
  2. energy range
  3. photon and electron beams
  4. clinical limitations
- B. Microtron
  1. basic design
  2. energy ranges
  3. advantages
- C. Cyclotron
  1. basic design
  2. energy range
  3. clinical applications
  4. radionuclide production

VI. Heavy Particle Beams
- A. Neutrons
- B. Protons and heavy ions
- C. Negative pions

VII. X-ray Equipment
- A. Simulator
  1. Use
  2. Components
     a. x-ray tube
     b. collimators
     c. field-defining wires
     d. film-tray or digital receptor
     e. fluoroscopic unit
- B. CT simulator
  1. Components

a. gantry
    i. tube
    ii. detectors
b. table
c. operating console
d. CPU, array processor and associated software
    i. image display
    ii. drawing program to outline volume of interest (VOI)
    iii. beam display
        (1) sectional images
        (2) beams eye view (BEV)
            (a) gantry/table rotation
            (b) dose distributions
        (3) dose volume histograms (DVH)
e. laser printer

2. Principles of image formation
    a. Image detectors
    b. Mathematical reconstruction algorithms
    c. Image reformatting
3. CT acquisition controls and effects on image
    a. Slice thickness
    b. Slice spacing and overlap
    c. mA
    d. Pitch anglei spinal CT
4. CT image characteristics
    a. Household units
    b. Matrix size
    c. Noise
    d. Artifacts
        i. Motion
        ii. Metal “Star” artifacts
        iii. Beam hardening
        iv. Partial volume
5. CT imaging processing controls
    a. Processing a algorithms
    b. Filtration
    c. Window Width
    d. Window Level
6. Filming images / Digitally reconstructed radiographs (DRR)
7. Reformatting in 3D

Instructional Indicators: Clinical Radiation Generators (CSLO-H, CSLO-I)

The student will:

1. For each of the following low energy machines list: (1) the operating energy range, (2) the suggested filtration, and (3) the normal treatment SSD:
    a. grenz b. contact c. superficial d. orthovoltage e. supervoltage

2. Discuss the disadvantages of using low energy radiation equipment when treating 'deep' tumors.
3. State the relationship between the photoelectric effect and radiation absorbed dose.
4. Differentiate between the beam's flatness and symmetry.
5. Discuss the concept of 'skin sparing'.
6. Compare the characteristics of scatter radiation created at lower energies (kV) as opposed to scatter created at higher energies (MV).
7. Define isocenter.
8. Define SAD and state the values normally associated with linear accelerators.
9. Explain the placement and importance of lasers in the treatment room.
10. Given a block diagram of a linear accelerator, correctly label each part.
11. For each of the following linear accelerator components, state the function(s):
    a. high voltage power supply
    b. modulator
    c. electron gun
    d. RF driver
    e. magnetron/klystron
    f. waveguide
    g. circulator
    h. dummy load
    i. cooling system
    j. accelerator guide
    k. bending magnet
    l. transmission target
    m. primary collimator
    n. flattening filter
    o. scattering foil
    p. dual ion chambers
    q. light
    r. mirror
    s. variable collimator
12. List all of the linear accelerator components that are located in the stand.
13. List all of the linear accelerator components that are located in the gantry.
14. List all of the linear accelerator components that are located in the treatment head.
15. Discuss the importance of a vacuum system in a linear accelerator.
16. List the gases used to pressurize a linear accelerator.
17. Differentiate between primary and variable collimators.
18. Trace the path of an electron beam from the bending magnet to the patient's skin.
19. Trace the path of a photon beam from the bending magnet to the patient's skin.
20. Identify any auxiliary equipment used in conjunction with a linear accelerator.
21. Discuss the purpose and construction of a beam stopper.
22. Discuss the possible methods of patient to therapist communication during radiation therapy treatments.
23. In conjunction with 'High Radiation Areas', differentiate between controlled and uncontrolled areas.
24. Differentiate between primary and secondary radiation barriers.
25. Describe the actions to be taken by the therapist in case of linear accelerator malfunction.
26. Given a diagram of a Cobalt-60 unit, correctly label each part.
27. Discuss the formation of Cobalt-60.
28. State the half life, average source life, average exposure rate, and monthly correction factor for a Cobalt-60 unit.
29. State the rationale for replacing a Cobalt-60 source every five years.
30. Describe how Cobalt-60 produces a useful treatment beam.
31. Given a diagram of the Cobalt-60 decay scheme, correctly label.
32. State the average (useful) energy of a Cobalt-60 source.
33. Differentiate between the beta emissions and gamma emissions of a Cobalt-60 source.

34. Given a diagram of a Cobalt-60 source, label it correctly.
35. Describe the physical appearance of a Cobalt-60 source.
36. Discuss the precautions that should be taken by radiation therapists when working on a Cobalt-60 unit.
37. Identify methods of exposing a Cobalt-60 source.
38. Discuss the importance of a 'timer error' when performing Cobalt-60 calculations.
39. Define penumbra.
40. Given the appropriate parameters, calculate the penumbra for a Cobalt-60 unit and a linear accelerator.
41. Discuss the purpose and placement of trimmers.
42. Discuss the limitations associated with the use of trimmers.
43. Discuss the importance of personnel monitoring of Cobalt-60 unit operators.
44. Describe the actions to be taken by the radiation therapist in the case of a Cobalt-60 source that will not retract.
45. Describe the actions to be taken by the radiation therapist in the case of a power failure when treating a patient on a Cobalt-60 unit.
46. Discuss the basic method of operation of a betatron, microtron, and cyclotron.
47. Discuss the importance of 'heavy particle' beams in radiation therapy.

11 / -- / Exam 2 Units 2-5

12 / Unit 6 / Interactions of Ionizing Radiation (CSLO-J)

Khan: Chapter 5

I. Radiation Qualities
  A. Intensity
    1. Inverse square
    2. Influencing factors
  B. Beam divergence versus beam attenuation
  C. Beam energy
    1. Monoenergetic (homogeneous)
    2. Polyenergetic (heterogeneous)

II. Ionization and excitation
  A. Definitions
  B. Linear energy transfer
  C. Indirect ionization
  D. Direct ionization

III. Interactions of photons
  A. Beam attenuation
    1. Influencing factors
      a. absorber atomic number
      b. energy
      c. absorber thickness
    2. Coefficients
      a. attenuation coefficient
        i. linear attenuation

ii. mass attenuation
iii. electronic attenuation
iv. atomic attenuation
b. energy transfer coefficient
c. energy absorption coefficient
3. Half value layer (HVL)
4. Measurement
a. semi-log
b. linear

IV. Interactions with matter
A. Transmission
B. Coherent scattering
1. description
2. probability
3. application
C. Photoelectric effect
1. description
2. energy range
3. probability
4. clinical association and significance
D. Compton effect
1. description
2. energy range
3. probability
4. special cases
a. direct hit
b. grazing hit
c. 90^{o} photon scatter
E. Pair production
1. description
2. energy range (threshold)
3. probability
4. annihilation radiation
5. clinical association and significance
F. Photodisintegration
1. description
2. application
G. Pair Annihilation
1. description
2. application

V. Interaction of charged particles
A. Heavy charged particles
1. rate of energy loss
2. Bragg peak
B. Electrons
1. lack of Bragg peak
2. Delta rays
3. Bremsstralung

VI. Interactions with Neutrons
VII. Comparative Beam Characteristics
    A. Energy
    B. Attenuation

Instructional Indicators: Interactions of Ionizing Radiation (CSLO-J)
The student will:
1. Discuss the intensity of a radiation beam in relation to the cardinal principles of time, distance, and shielding.
2. Discuss the inverse square law and its relationship to radiation intensity.
3. Recall the factors that influence radiation intensity.
4. Differentiate between beam divergence and beam attenuation.
5. Recall the formula relating to beam attenuation.
6. Define ionization.
7. Compare and contrast ionization and excitation.
8. Define linear energy transfer and state its importance.
9. Compare and contrast direct and indirect ionization.
10. Discuss the factors that influence beam attenuation.
11. Compare and contrast attenuation coefficient, energy transfer coefficient, and energy absorption coefficient.
12. Describe the process of coherent (classical) scattering.
13. Describe the process involved with the photoelectric effect.
14. Describe the process involved with the Compton effect.
15. Discuss the relationship between the Compton effect, energy, and atomic number.
16. Describe a pair production interaction.
17. Describe photodisintegration.
18. Describe pair annihilation.
19. Define Bragg peak.
20. Discuss the interactions of electrons.
21. Discuss the interactions of neutrons.

13 / -- / Mock Registry [time permitting]

14 / Unit 7 / Measurement of Ionizing Radiation (CSLO-E, CSLO-K)
Khan: Chapter 6

I. Introduction
II. Units
    A. Roentgen
        1. Abbreviation
        2. Associate SI unit/Abbreviation
        3. Definition
        4. Numerical expression/equivalent
    B. Rad
        1. Associated SI unit/abbreviation
        2. Definition

3. Numerical expression/equivalent

C. REM
   1. Associated SI unit/abbreviation
   2. Definition
   3. Numerical expression/equivalent

D. Curie
   1. Abbreviation
   2. Association SI unit/abbreviation
   3. Definition
   4. Numerical expression/equivalent

E. Electron volt
   1. Abbreviation
   2. Associated SI unit/abbreviation
   3. Definition
   4. Numerical SI unit/abbreviation

F. Other
   1. Ergs
   2. Joules

II. Collection of Charge Instruments

A. Free-air ionization chambers
   1. Schematic of free-air chamber
      a. electric field
      b. ion collection plate
      c. current
      d. specified air volume
      e. electronic equilibrium
      f. saturation
   2. Limitations

B. Thimble chambers
   1. Function
   2. Principle of operation
      a. air equivalence
      b. chamber wall
         i. effective atomic number
         ii. electronic equilibrium and build up caps
      c. central electrode
      d. air cavity, sensitive volume, and sensitivity
   3. Calibration
   4. Desirable chamber characteristics

C. Practical thimble chambers
   1. Condenser chambers
   2. Farmer chambers

III. Electrometers

A. Charge measurement

B. String electrometer

IV. Special Chambers

A. Extrpolation chamber

B. Parallel-plate chamber

V. Environmental conditions
   A. Standard temperature and pressure (STP)
   B. Standard calibration of temperature and pressure

VI. Measurement of Exposure

Instructional Indicators: Measurement of Ionizing Radiation (CSLO-E, CSLO-K)

The student will:

1. For the following radiologic units, give (1) the abbreviation, (2) the associated SI unit and abbreviation, (3) a definition, and (4) the numerical expression/equivalent, if applicable.
2. Discuss the principles of operation of a free-air ionization chamber.
3. Discuss the limitations associated with using a free-air ionization chamber to measure ionizing radiation.
4. Discuss the principles of operation of a thimble chamber.
5. Discuss the calibration of a thimble chamber.
6. Describe the desirable characteristics of a thimble chamber.
7. Compare and contrast a condenser chamber and a farmer chamber.
8. Discuss the basic operation of a electrometer.
9. Discuss the environmental conditions that can affect the operation of radiation measurement devices.

14 / Unit 8 / Quality of X-ray Beams (CSLO-K)

Khan: Chapter 7

I. Half Value Layer (HVL)
   A. Definition
   B. Low energy beams
   C. Megavoltage beams
   D. Average energy

II. Filters
   A. Inherent filters
   B. Added filters
   C. Combination filters (Thoreus)
   D. Use
      1. low energy beams
      2. megavoltage beams

III. Measurement of Beam Quality
   A. HVL
   B. Peak Voltage
      1. Direct measurement
      2. Indirect measurement
   C. Effective energy
   D. Mean energy

IV. Measurement of Megavoltage Beam Energy
   A. Percentage depth dose (PDD)
   B. Tissue-air ratios (TAR)
   C. Tissue-maximum ratios (TMR)

D. Photoactivation ratio (PAR)

V. Measurement of Energy Spectrum

Instructional Indicators: Quality of X-ray Beams (CSLO-K)

The student will:

1. Define half value layer (HVL).
2. Compare and contrast the half value layers for low and high energy beams.
3. Describe the concept of beam filtration and discuss how it affects beam quality.
4. Differentiate between inherent and added filtration.
5. Discuss the composition of a Thoreus filter.
6. Describe how peak voltage can be used to measure beam quality.
7. Compare and contrast effective and mean energy of an x-ray beam.
8. Discuss the measurement of a megavoltage radiation beam.

15/ - /Review for Final Exam

16 / - / Final Exam

INSTRUCTIONAL ACTIVITIES:

- **Math Notebook**: Students compile a notebook of math problems over the course of the math review. This notebook is graded for completeness at the time of the math post test. (CSLO-A)
- **Structure of Matter Problems**: These problems are designed to challenge the students over topics surrounding the structure of matter. Many of the problems require the students to think critically and/or search for information via the internet. (CSLO-A, CSLO-B, CSLO-C)
- **Activity Problems**: These problems provide the students with practice using the decay formula. (CSLO-A, CSLO-D, CSLO-E)
- **Historical Development Assignment:** This assignment encourages the students to use their radiologic technology textbooks or the internet to recall information about the historical beginnings of the radiological sciences. (CSLO-F, CSLO-G)
- **Clinical Radiation Generators and Simulator Group Assignments:** Students work alone or together in small groups to research an assigned piece of radiation therapy equipment. They prepare a presentation and handout to share with the class. (CSLO-H, CSLO-I)
- **Interaction with Ionizing Radiation Problems:** These problems are designed to challenge the students over topics surrounding the interaction of ionizing radiation with matter. (CSLO-J)
- **Measurement of Ionizing Radiation Problems:** These problems are designed to challenge the students over topics surrounding the measurement of ionizing radiation. (CSLO-E, CSLO-K)

- **Mock Registry Exam and Review:** This exam is designed to test the students' abilities to recall knowledge learned over the course of the program and to apply it in a variety of situations. This exam is meant to 'simulate' the national certification examination in radiation therapy and are used a preparatory mechanisms. (CSLO-A, CSLO-B, CSLO-C, CSLO-D, CSLO-E, CSLO-F, CSLO-G, CSLO-H, CSLO-I, CSLO-J, CSLO-K)
- **Unit/Final Exams:** Each unit will be covered by a corresponding unit exam. The final exam is comprehensive.

CSLO/Assessment Alignment: See above for descriptions

CSLO:	**CSLO-A**	**CSLO-B**	**CSLO-C**	**CSLO-D**
Assessments:	• *Math notebook* • *Struct of matter prob* • *Activity prob* • *Mock registry* • *Unit 1 exam* • *Final exam*	• *Struct of Matter prob* • *Mock registry* • *Unit 2 exam* • *Final exam*	• *Struct of matter prob* • *Mock registry* • *Unit 2 exam* • *Final exam*	• *Activity prob* • *Mock registry* • *Unit 2 exam* • *Final exam*
CSLO:	**CSLO-E**	**CSLO-F**	**CSLO-G**	**CSLO-H**
Assessments:	• *Activity prob* • *Measure of ion rad prob* • *Mock registry* • *Unit 2 exam* • *Final exam*	• *Hist dev assign* • *Mock registry* • *Unit 2 exam* • *Final exam*	• *Hist dev assign* • *Mock registry* • *Unit 2 exam* • *Final exam*	• *CRGS group assign* • *Mock registry* • *Unit 3 exam* • *Final exam*
CSLO:	**CSLO-I**	**CSLO-J**	**CSLO-K**	
Assessments:	• *CRGS group assign* • *Mock registry* • *Unit 3 exam* • *Final exam*	• *Interact w/ ion rad prob* • *Mock registry* • *Unit 3 exam* • *Final exam*	• *Measure of ion rad prob* • *Mock registry* • *Unit 3 exam* • *Final exam*	

COURSE DELIVERY FORMAT:
This format is the traditional format and may use an online format to provide access to "static" materials which include the syllabus, course material, contact information, and presentations. Faculty must make available when requested a copy of syllabus and any other instructor provided course materials, including their contact information. Faculty may require on-line activities and assignments to include online tests and submission of all written and on-line communications. The extent of on-line activities/assignments may vary by course but will be specified on the syllabus.

TEACHING /LEARNING METHODS:

Lectures / Demonstrations	Reading / Quizzes / Homework Assignments
Clinical Assignments	Online Discussions

EVALUATION GUIDELINES:

Course grade will be derived as follows:

50% Unit examinations	15% Homework/Quizzes
10% Math Notebook	25% Final Exam

GRADING POLICY:

90 – 100……A
80 – 89 ……B
70 – 79……C
60 – 69……D
59 – below…….F

Note: Students must achieve an average of 75% or better to remain in the program.

Late assignments will only receive a maximum of 75% of the grade assigned.

COLLEGE POLICIES:

This class is governed by the policies and procedures stated in the current Chattanooga State Student Handbook. Additional or more specific guidelines may apply.

ADA STATEMENT:

Students who have educational, psychological, and/or physical disabilities may be eligible for accommodations that provide equal access to educational programs and activities at Chattanooga State. These students should notify the instructor immediately, and should contact Disabilities Support Services within the first two weeks of the semester in order to discuss individual needs. The student must provide documentation of the disability so that reasonable accommodations can be requested in a timely manner. All students are expected to fulfill essential course requirements in order to receive a passing grade in a class, with or without reasonable accommodations.

DISRUPTIVE STUDENTS:

The term "classroom disruption" means – student behavior that a reasonable person would view as substantially or repeatedly interfering with the activities of a class. A student who persists in disrupting a class will be directed by the faculty member to leave the classroom for the remainder of the class period. The student will be told the reason(s) for such action and given an opportunity to discuss the matter with the faculty member as soon as practical. The faculty member will promptly consult with the division dean and the college judicial officer. If a disruption is serious, and other reasonable measures have failed, the class may be adjourned, and the campus police summoned. Unauthorized use of any electronic device constitutes a disturbance. Also, if a student is concerned about the conduct of another student, he or she should please see the teacher, department head, or division dean.

AFFIRMATIVE ACTION:

Students who feel that he or she has not received equal access to educational programming should contact the college affirmative action officer.

ACADEMIC INTEGRITY/ACADEMIC HONESTY:

In their academic activities, students are expected to maintain high standards of honesty and integrity. Academic dishonesty is prohibited. Such conduct includes, but is not limited to, an attempt by one or more students to use unauthorized information in the taking of an exam, to submit as one's own work, themes, reports, drawings, laboratory notes, computer programs, or other products prepared by another person, or to knowingly assist another student in obtaining or using unauthorized materials. Plagiarism, cheating, and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly through participation or assistance, are immediately responsible to the instructor of the class. In addition to other possible disciplinary sanctions, which may be imposed through the regular institutional procedures as a result of academic misconduct, the instructor has the authority to assign an "F" or zero for an activity or to assign an "F" for the course.

EMAIL COMMUNICATION:

Please note all communication with instructors about your course work should be through the eLearn Email system. For assistance on how to use the eLearn Email tool go to this url: http://river.chattanoogastate.edu/orientations/Student_PDFs/eLearn_eMail_aug09.pdf.

For all other communication the official email system used by the college is through Tiger Mail. This is accessible by clicking the blue paw icon from the top right hand side of your Tiger Web home page https://tigerweb.chattanoogastate.edu/cp/home/displaylogin.

The instructor reserves the right to modify this syllabus, in writing, anytime during the course of the semester.

Revised 10/10/ldl