COURSE DEFINITION:
RAD 540-3 The Physics of Medical Dosimetry II – This course covers the following topics: imaging for radiation oncology, IMRT, stereotactic radiosurgery, special procedures, particle therapy, hyperthermia, and radiation safety. This course is twenty weeks in length. Prerequisite: A grade of “C” or better in RAD 520.

COURSE OBJECTIVES:

1. Demonstrate an understanding of imaging in radiation oncology.
2. Demonstrate an understanding of IMRT.
3. Demonstrate an understanding of stereotactic radiosurgery and gamma knife.
4. Demonstrate an understanding of particle therapy.
5. Demonstrate an understanding of hyperthermia.
6. Demonstrate an understanding of radiation safety.

COURSE OUTLINE:

Topics
1. Oncology imaging
2. IMRT techniques
3. Stereotactic radiosurgery and gamma knife
4. Particle therapy
5. Hyperthermia
6. Radiation safety

COURSE REQUIREMENTS:

Purchase all texts, attend all lectures, and complete required examinations, quizzes, and homeworks. Purchase a T130XA scientific calculator.

PREREQUISITES: A grade of “C” or better in RAD 520.

TEXTBOOKS:

Required:

Optional: (Students typically use clinical sites’ copy)

**GRADING SCALE:**

<table>
<thead>
<tr>
<th>Range</th>
<th>Grade</th>
</tr>
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<tbody>
<tr>
<td>90-100</td>
<td>A</td>
</tr>
<tr>
<td>80-89</td>
<td>B</td>
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<tr>
<td>70-79</td>
<td>C</td>
</tr>
<tr>
<td>&lt;70</td>
<td>Failing</td>
</tr>
</tbody>
</table>

Grades will be determined by:

- Test Performance: 65%
- Quizzes/Homework: 35%

**Note:** An overall GPA of 3.0 or greater in all graduate coursework is required to successfully complete the Medical Dosimetry Program. This is a SIUC Graduate School Policy.
1, 2 01/05/15  
01/07/15  
**Brachytherapy Principles**  
**O. Wooten**  
A. Handling of Sealed Radioactive Sources  
B. Dose Distributions for Sealed Implant Source  
C. Radium and Radium Substitutes  
  1. Radium Source Specification  
  2. Radium Source Types  
  3. Exposure Rate Constant  
  4. Exposure Rate Calculations  
  5. Disadvantages of Radium  
  6. Replacement Sources for Radium  
D. Sealed Source Production and Decay Mechanisms  
E. Other Sealed Sources in Therapy  
F. Unsealed Source Production and Decay Mechanisms  
G. Converting Between mgRaEq and mCi  
H. Remote Afterloading Units  
  1. Low Dose Rate (LDR)  
  2. High Dose Rate (HDR)  
  3. Calibration  

3, 4 01/12/15  
01/14/15  
**Brachytherapy Dosimetry**  
**O. Wooten**  
A. Point Source Calculations  
B. Linear Source Calculations  
  1. Sievert Integral  
  2. Approximations  
  3. Along and away tables  
C. TG-43 Formalism  

5, 6 01/21/15  
01/26/15  
**HDR Procedures**  
**O. Wooten**  
A. Afterloader principles  
B. Source and transfer system design  
C. Treatment sites  
D. Treatment planning  
E. Quality assurance  

7 01/28/15  
**Brachytherapy Intracavitary**  
**O. Wooten**  
A. Linear Source Implant Calculations  
  1. Along and Away Tables  
B. Intracavitary Applications  
  1. Cylinders  
    a) Surface Dose and Cylinder Size  
  2. Tandem and Ovoid  
    a) Classical Intracavitary Dosage Systems  
      (1) Prescription Points  
      (2) Dosage Systems  
C. ICRU Report 38 Dose Reporting  
  1. Source Information  
  2. Applicator Information  
  3. Source Strength  
  4. Reference Volume  
  5. Reference Point Doses  
  6. Time-Dose Patterns
8 02/02/15 **Interstitial Implants**

A. Paterson-Parker System
   1. Planar Implant
   2. Volume Implant
B. Quimby System
   1. Planar Implant
   2. Volume Implant
C. Paris System

9, 10 02/04/15 **Prostate Breast, Eye Brachytherapy Implants**

02/09/15

A. I-125, Pd-103 for Prostate
B. HDR for Prostate
C. HDR for Breast
D. Eye Applicators, Plaques
   COMS protocol
   Sr-90 applicators

11 02/11/15 **Radiopharmaceutical**

A. Methods of production and Clinical treatments
   - Reactor-produced isotopes
   - Cyclotron-based production
   - Isotope decay characteristics
   - Radiochemistry basics
   Clinical treatments using internally administered radioisotopes
   - Iodine treatment for thyroid
   - Radioimmunotherapy
   - Microspheres
   - Emerging treatments
B. Internal dosimetry and Safety
   - Dosimetry systems
   - Compartmental models
     MIRD method
     Dose estimates for embryo/fetus and breast-feeding infant
     Radiation safety
   - Equipment
     Survey meters, NaI probes, well counters, radionuclide calibrators
     Instrument quality controls and checks
   - Safety procedures
     Radiation protection
     Internal protection
     Decontamination
     Written directive/medical event
     Package receipt
     Area surveys
   - Regulations

12 02/16/15 **Section 3 Exam - Brachytherapy Physics**

**Section 4: Imaging, IMRT, Special Procedures, Radiation Safety**
13 02/18/15 **Imaging for Radiation Oncology: MRI** - S. Mutic

Physical principles
- T1, T2, TE, TR imaging characteristics
- Advantages & limitations of MRI images for diagnosis and computerized treatment planning


02/25/15

A. Ultrasound
- Physical principles
  - Utility in diagnosis and patient positioning
  - PET Imaging

B. PET Physical principles
- Utility for Radiation Therapy
- SPECT

C. Electronic Portal Imaging
  - Overview of electronic portal imaging devices
  - Types of portal imaging devices
  - Clinical applications of EPID technology in daily practice

16 03/02/15 **Imaging: Radiographic, CT, 4D** - S. Mutic

A. Diagnostic Imaging
- Physical principles
- Port Film Imaging
- Film based
  - XV-2 film, EDR-2 film characteristics

B. CT
- Physical principles: Serial, Helical
- Hounsfield Units, CT numbers, inhomogeneity corrections based on CT scan images

17 03/04/15 **Imaging: Fusion, Image Registration** - S. Mutic

A. Image Fusion
- Advantages
- Challenges
- Techniques
- Limitations

B. Deformable body/structure image fusion

C. Quality assurance
- Image transfer process, accuracy, fidelity
- Image fusion process

18, 19, 03/16/15 **IMRT** - S. Mutic

20 03/18/15

03/23/15

A. IMRT Delivery Systems

1. Segmental MLC (SMLC) and Dynamic MLC (DMLC)
2. Serial Tomotherapy (MIMiC)
3. Helical Tomotherapy
4. Robotic Linac

B. Simulation, Dose prescription & inverse planning

1. Organ motion and IMRT (prostate, parotid, lung, patient weight loss during treatment, etc.)
2. Treatment calculations
3. “Forward planned” IMRT
4. Compare/contrast various treatment planning software available
5. How to distinguish a good IMRT plan versus a poor IMRT plan
C. IMRT Quality assurance
   1. Systematic QA
   2. Patient specific QA
   3. Record/verify

D. ViewRay
   1. Basic magnetic field and MRI concept review
   2. Overview of MRI-guided delivery systems
   3. Treatment planning
   4. Quality assurance for an MRI-guided delivery system
   5. ViewRay-specific operations issues (NRC overview, MRI safety, etc)

21  03/25/15  Informatics  R. Kashani
   A. DICOM
   B. PACS
   C. Network Integration and Integrity
   D. Storage and Archival
   E. IS Maintenance

22, 23  03/30/15  Radiation Safety  E. Klein
   04/01/15
   A. Concepts and Units
      1. Radiation Protection Standards
      2. Quality Factors
      3. Definitions for Radiation Protection
      4. Dose Equivalent
         a) Units of Dose Equivalent
      5. Effective Dose Equivalent
   B. Types of Radiation Exposure
      1. Natural Background Radiation
      2. Man-Made Radiation
      3. NCRP #91 Recommendations on Exposure Limits
   C. Protection Regulations
      1. NRC Definitions
         a) Recordable Event
         b) Misadministration
      2. NRC Administrative Requirements
         a) Radiation Safety Program
         b) Radiation Safety Officer
         c) Radiation Safety Committee
         d) Quality Management Program
      3. NRC Regulatory Requirements

24, 25  04/06/15  Stereotactic Radiosurgery  R. Kashani
   04/08/15
   A. SRS Delivery Systems
      1. Linac based
      2. Gamma Knife
      3. Robotic Linac
   B. Simulation and immobilization/repositioning
   C. Dose prescription & treatment planning
   D. Treatment calculations
   E. SRS quality assurance
Particle Therapy

A. Protons
- Proton Beam Energy Deposition
- Equipment for Proton Beam Therapy
- Clinical Beam Dosimetry
- Clinical Proton Beam Therapy
- Treatment Planning
- Treatment Delivery
- Clinical Applications
- Clinical Beam Dosimetry

B. Other Particles
- Carbon
- Neutrons

C. Biology
- LET
- RBE

Special Procedures

A. TBI
1. Patient Set-up
2. Dosimetry
3. Selection of energy, field size, distance
4. MU calculations

B. ESRT
C. TSET
D. Electron Arc

Radiation Shielding

A. Treatment Room Design
1. Controlled/Uncontrolled Areas
2. Types of Barriers
3. Factors in Shielding Calculations
   a) Workload (W)
   b) Use factor (U)
   c) Occupancy factor (T)
   d) Distance

B. Shielding Calculations
1. Primary Radiation Barrier
2. Scatter Radiation Barrier
3. Leakage Radiation Barrier

C. Sealed Source Storage
D. Protection Equipment and Surveys
1. Operating Principles of Gas-filled Detectors
2. Operating Characteristics
3. Radiation Monitoring Equipment
   a) Ionization chamber (Cutie Pie)
   b) Geiger-Mueller Counters
   c) Neutron Detectors
4. Personnel Monitoring

Section 4 Exam – Imaging, IMRT, etc.