

**Clinical Rotation 3: PHYS 705**  
**Fall (3<sup>rd</sup> Week of Aug. – 3<sup>rd</sup> Week of Feb.)**  
COURSE INFORMATION

Days: Monday-Friday  
Times: Full Time  
Location: One of the participating cancer clinics

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## 1. Course Overview

**Description from the Official Course Catalog:**

On-site, full-day clinical training in the principles of computed tomography (CT) simulator, associated radiation protection/design considerations, CT protocols. Understand the physics of imaging modalities, image guided radiotherapy, image archiving and communication systems, and perform quality assurance on CT, MRI, ultrasound and PET as related to radiation therapy. On board imaging procedures are also covered.

**Description of the Purpose and Course Content:**

This course is a clinical rotation that comprises an integral part of the residency training for radiation oncology physics. It is designed to be in accordance with American Association of Physicists in Medicine (AAPM) Task Group 249, 'Essential and Guidelines for Hospital based Medical Physics Residency Training Programs', and the Commission on Accreditation of Medical

Physics Educational Programs (CAMPEP). The course will also include didactic coverage of the topics during biweekly resident sessions at SDSU.

This clinical rotation course extends over the third six-months of the certificate program and consists of rotations through areas of computed tomography (CT) simulation, associated radiation protection/design considerations, CT protocols, image guided radiotherapy, image archiving and communication systems, some treatment planning, and quality assurance on CT, MRI, ultrasound, PET as related to radiation therapy. Objectives are established at the commencement of the course. The student's performance is evaluated by direct observation, a project/progress report, and bimonthly oral examinations administered by the supervising Medical Physicist including a final oral examination by the Advisory Committee. The work at the clinic, including self-study of reading material and contact hours of the Resident with the clinic team (i.e., Medical Physicists, Dosimetrists, Radiation Oncologists, Radiation Therapists) and chart rounds/tumor board meetings will be full time.

Note: The proposed course requires access to external beam radiotherapy equipment, simulation equipment, imaging equipment, treatment planning equipment, and quality assurance equipment that are only available at community/academic cancer centers. Arrangements will be made to have board certified Clinical Medical Physicists at the hospitals train the residence in all aspects of the physics of external beam radiation therapy including equipment usage and quality assurance. Once trained, the Resident will be expected to perform routine quality control of the equipment available at the assigned cancer center under the supervision of a qualified Medical Physicist.

In addition to the clinical activities below, the resident is expected to attend one medical physics conference per year and the following activities at SDSU:

- Biweekly didactic resident sessions covering the clinical topics below and resident progress/concerns (~2 hours/session)
- Medical physics seminars (~ 4 per rotation).

#### I. CT Simulator-Total 8 weeks

##### A. Selection (1 week)

1. Performance specification
2. Feature comparison
3. Mechanical/architectural considerations
4. Performance test design

##### B. Protection/design/architectural (2 weeks)

1. Walls/ceiling/floor
2. Control area
3. Darkroom
4. Room survey
5. Regulations: federal, state, local

##### C. Acceptance testing (2 weeks)

1. Diagnostic image quality tests
2. Dose calculations
3. Geometry tests (digitally reconstructed radiographs [DRRs], etc.)
4. Networking tests

##### D. Quality assurance (2 weeks)

1. Geometric accuracy
2. Imaging
3. Networking

##### E. CT protocols (1 week)

#### II. Imaging-Total 9 weeks

##### A. CT (2 weeks)

1. Scanning systems and techniques
2. Geometric accuracy
3. Density tables
4. 4-D CT (four-dimensional CT)

##### B. MRI (2 weeks)

1. Scanning systems and techniques
  2. Geometric accuracy
  3. MRI-CT image registration
- C. Ultrasound (1 week)
1. Scanning systems and techniques
  2. Tumor positioning
- D. PET (2 weeks)
1. Scanning systems and techniques
  2. Tumor localization
  3. Image registration
- E. Picture archiving and communication system (PACS)/Informatics (2 weeks)
1. Digital Imaging and Communications in Medicine (DICOM)
  2. DICOM RT (DICOM in Radiation Therapy)
  3. PACS systems and their integration
  4. DICOM standards
  5. Information acquisition from PACS/images
  6. Quality/maintenance of imaging workstations
  7. Evaluation of viewing conditions
  8. Quantitative analysis
  9. Network integration/management, and roles of physics and information technology staff
- III. On Board MV & kV Imaging & Associated QA (1.5 weeks)
1. General
  2. 2D Imaging techniques and 3D (e.g., CBCT)
- IV. Proton Therapy (1.5 weeks)

## 2. Student Learning Outcomes & Competency Evaluation Metrics

All of the outcomes listed in Appendix 1 of Clinical Rotation 3 below will be assessed by measurable competencies in clinical measurements and practice, oral evaluations, written reports and a final oral exam. Many of the objectives, learning outcomes, and competency evaluation metrics given in Appendix 1 of this syllabus have been adapted from AAPM Report Task Group 249.

**A competency of "Meets Expectations" (i.e., score  $\geq 3$ ) is required on all oral examinations and competency checklist to pass the rotation.**

### Real Life Relevance:

This clinical rotation course provides practical hands on clinical training in radiation oncology physics.

### Relation to Other Courses:

This is the third clinical rotation course in the Advanced Certificate of Medical Physics Residency Program. The topics covered in this and the other clinical rotations are core requirements for the Commission on Accreditation of Medical Physics Education Programs (CAMPEP).

## 3. Enrollment Information

### Prerequisites:

Clinical Rotation 2 (PHYS- 703)

### Adding/Dropping Procedures:

The course must be added before the end of the second week of the semester. Dropping procedures will follow the Physics Department guidelines. Note: Dropping a clinical rotation course is effectively equivalent to withdrawing from the residency program.

#### 4. Course Materials

##### Required & Recommended Materials:

The following task group publications available at <http://www.aapm.org/pubs/reports/> from the American Association of Physicists in Medicine (AAPM) and books and will be the references for the course:

1. Radiation Oncology Physics: A Handbook for Teachers and Students, by E. B. Podgorsak. Radiation Oncology Physics: A Handbook for Teachers and Students, by E. B. Podgorsak. International Atomic Energy Agency, Vienna, Austria. Date Published: 2005. PDF available for free download at:  
[http://www-pub.iaea.org/MTCD/publications/PDF/Pub1196\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/Pub1196_web.pdf)
2. The Modern Technology of Radiation Oncology: A Compendium for Medical Physicists and Radiation Oncologists, Volume 1, Editor: Jacob Van Dyk, Medical Physics Publishing Corporation, 1999.
3. The Modern Technology of Radiation Oncology: A Compendium for Medical Physicists and Radiation Oncologists, Volume 2, Editor: Jacob Van Dyk, Medical Physics Publishing Corporation, 2005.
4. AAPM REPORT NO. 74 Quality Control in Diagnostic Radiology, Report of Task Group #12, Diagnostic X-ray Imaging Committee, Medical Physics Publishing, 2002.
5. Quality assurance for computed-tomography simulators and the computed tomography- simulation process: Report of the AAPM Radiation Therapy Committee Task Group No. 66. Medical Physics, Vol. 30, Issue 10, 2003.
6. The Measurement, Reporting, and Management of Radiation Dose in CT: Report of the AAPM Task Group 23, American Association of Physicists in Medicine, 2008.
7. The management of imaging dose during image-guided radiotherapy: Report of the AAPM Task Group 75, Medical Physics, Vol 34, Issue 10, 2007.
8. Quality assurance for image-guided radiation therapy utilizing CT-based technologies: A report of the AAPM TG-179 Medical Physics, Vol 39, Issue 4, 2012.
9. AAPM TG-53. Quality Assurance for Clinical Radiotherapy Treatment Planning, Medical Physics 25(10): 1773–1829, 1998.
10. IAEA TRS 430. Commissioning and Quality Assurance of Computerized Planning Systems for Radiation Treatment of Cancer. Technical Reports Series (TRS) No. 430. Vienna, Austria: International Atomic Energy Agency, 2004.
11. Bushberg et al., "The Essential Physics of Medical Imaging," 3<sup>rd</sup> Ed. 2011.
12. Huda, "Review of Radiologic Physics," 3<sup>rd</sup> Ed. 2009.
13. NCCN guidelines for treatment of cancer by site:  
[http://www.nccn.org/professionals/physician\\_gls/f\\_guidelines.asp#site](http://www.nccn.org/professionals/physician_gls/f_guidelines.asp#site)

#### 5. Course Structure and Conduct

##### Style of the Clinical Rotation:

- Residents will be trained by the Certified Clinical Medical Physicist to perform hands on clinical duties in the cancer center.
- Once trained the residents will gain practice by performing routine clinical duties.
- Residents will be responsible for learning the recommended reference materials on their own.

## 6. Course Assessment and Grading

### Grading Scale:

The Resident's performance will be evaluated by direct observation, project/progress reports, and **three** oral evaluations (approximately bimonthly) administered by the supervising Medical Physicist. Note: The final oral examination is cumulative and will be administered by the Advisory Committee.

One of the writing components of this course will include a report by the resident that describes all of the clinical activities/projects in which they participated. The report will include the objectives and relevance, description, methods, and discussion/conclusions of each major clinical activity/project. Special assigned clinical project reports may also be included.

The final assessment breaks down as follows:

1. Observation of clinical measurements and practice by supervising Medical Physicist: 10%
2. Bimonthly oral evaluations based on the clinical rotation topics (Approximately ranging from 20 minutes to 1 hour long): 40%
3. Project/progress and reports: 20%
4. Final presentation and oral exam (1 hour): 30%

The following evaluation scheme from 1 to 5 will be used:

1. Unsatisfactory
  - Performance and/or consistency is below standard in most/all areas covered by evaluation
  - Immediate and consistent improvement to "Meets Expectations" rating is required in next evaluation and final oral exam
2. Needs Improvement
  - Performance and/or consistency is below standards in certain areas and improvement is needed
3. Meets Expectations
  - Competent level of performance that consistently meets high standards
4. Above Expectations
  - Examination results exceed expectations
  - Performance is consistently high quality
5. Outstanding
  - Knowledge of evaluation material is exceptional and consistently superior

The resident will be assigned a pass/fail for the course. An overall score of 3 or greater constitutes a pass. If the resident fails one section of the rotation, they will be given one chance to prepare and re-take the oral exam for that section two weeks later. A copy of all evaluations will be sent to the Program Director.

### Excused Absence Make-up Policies:

Students should have an extraordinary reason (e.g., illness, death in the family, etc.), with proof, to miss the oral examination or final oral examination. A make-up for such a case will be arranged with the Advisory Committee

## 7. Other Course Policies

### The residents are expected to:

- Engage with supervising Medical Physicist for training.
- Record daily activities and time spent in the clinic. This will be reviewed by regularly the supervising Medical Physicist and quarterly by the Advisory Committee.
- Report for duties at the clinic and meetings on time.
- Perform assigned readings, presentations, lectures, and clinical duties in a timely manner.
- Attend medical physics seminars (approximately 4 per semester) at SDSU.
- Attend all of the biweekly resident sessions at SDSU.
- Attend one Medical Physics Conference each year (e.g., the AAPM, ASTRO, or COMP Annual Meeting).
- Report any QC results that are out of tolerance to the supervising or other qualified Medical Physicist at the clinic as soon as possible.

- Hand in project and progress reports by assigned deadline.
- Dress appropriately in the clinic (e.g., dress shirt and dress pants).
- Interact respectfully with all staff members and patients in the clinic.
- Advise the supervising Medical Physicist and Program Director of planned absences (e.g., vacation time or sick leave).  
A record of vacation days absent shall be kept by the Associate/Program Director and should not exceed the allotted two weeks per six-month semester. In addition, the holidays allotted to Medical Physicists at the center are applicable to the resident. The resident may also take up to 1.5 days of personal leave per six-month rotation.

**Note:**

A senior resident will be chosen to be part of the Advisory Committee to provide input on resident issues and concerns.

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that I cannot provide accommodations based upon disability until I have received an accommodation letter from Student Disability Services. Your cooperation is appreciated.

<b>RADIATION ONCOLOGY RESIDENCY PROGRAM</b> <b>Competency Evaluation of Resident</b>		
<b>Resident's Name:</b>		
<b>Rotation:</b>	PHYS 705: Clinical Rotation 3	
<b>Inclusive dates of rotation:</b>		
<b>Director or Associate Director:</b>		
<b>Competency Assessment Scheme:</b> <ol style="list-style-type: none"> <li>1. Unsatisfactory           <ul style="list-style-type: none"> <li>• Performance/Knowledge is below standard</li> </ul> </li> <li>2. Needs Improvement           <ul style="list-style-type: none"> <li>• Performance/Knowledge is below standards in certain areas and improvement is needed</li> </ul> </li> <li>3. Meets Expectations           <ul style="list-style-type: none"> <li>• Performance/knowledge that consistently meets high standards of competency</li> </ul> </li> <li>4. Above Expectations           <ul style="list-style-type: none"> <li>• Performance/Knowledge exceeds expectations</li> <li>• Performance/Knowledge is consistently high quality</li> </ul> </li> <li>5. Outstanding           <ul style="list-style-type: none"> <li>• Performance/Knowledge is exceptional and consistently superior</li> </ul> </li> </ol>		
Evaluation criteria	Competency (from 1 – 5)	Explanatory Notes & Mentor Signature
<b>Computed Tomography (CT) Simulators - General</b>		
a. Demonstrates understanding of the nuances of CT simulators with those of diagnostic CT scanners (e.g., in terms of lasers, table top indexing, localization software, bore size)		
b. Demonstrates an understanding of the theory of CT imaging reconstruction and of the operation of a CT simulator		
c. Demonstrates an understanding of the major subsystems and components of a CT simulator		
d. Demonstrates an understanding of the room shielding and other radiation protection requirements of a CT simulator		
<b>Computed Tomography (CT) Simulators - Selection</b>		
a. Reviews the steps required to select a new CT simulator, including performance		

specification and feature comparison		
b. Reviews and understands the mechanical/architectural considerations relevant to installing a new CT simulator in both new and existing rooms		
<b>Computed Tomography (CT) Simulators – Acceptance Testing &amp; Quality Control</b>		
a. Demonstrates an understanding of the mechanical tests performed during a CT simulator acceptance procedure		
b. Demonstrates an understanding of the tests of image quality and characteristics for a CT image and DRR for a CT simulator		
c. Demonstrates an understanding of the measurement of dose and the computed tomography dose index (CTDI) from a CT simulator for different body sites		
d. Demonstrates an understanding of the measurement of CT number as opposed to density calibration with kVp and CT number used in treatment planning systems		
e. Demonstrates an understanding of the alignment of internal and external laser systems in a CT simulator		
f. Demonstrates an understanding of network connectivity tests between other systems used in the radiation oncology process (e.g., treatment planning systems, treatment verification systems, PAC system)		
g. Demonstrates an understanding of the validation tests related to the transfer of CT-imaged objects to treatment planning systems		
<b>Computed Tomography (CT) Simulators – Radiation Safety</b>		
a. Demonstrates an understanding of state/provincial licensing of x-ray producing devices		
b. Explains the principles behind a radiation protection program, including the rationale for the dose limits for radiation workers and members of the public		
c. Describes the key parameters necessary to perform a shielding calculation		
d. Describes the significance of an isodose distribution plot for a CT simulator		
e. Demonstrates an understanding of structural shielding designs for a CT simulator and performs a shielding calculation (walls, ceilings, floor, and control area)		



f. Demonstrates an understanding of film processing and darkroom design		
<b>Computed Tomography (CT) Simulators – Dose Calculations</b>		
a. Understands the physical basis for the use of CT-simulator images in treatment planning as the current standard for dose calculations		
b. Understands the calibration of these CT-simulator images for computing radiation dose deposition in different tissues		
<b>Computed Tomography (CT) Simulators – Quality Assurance</b>		
a. Competently performs routine QA test processes for CT simulators and understands the QA test processes relationship to acceptance testing and commissioning measurements		
b. Understands the bases of recommended measurements for CT-simulators and the measurements tolerances specified by the AAPM, ACR, and other professional bodies		
c. Understands and competently determines the geometric accuracy of laser alignment, couch motion, gantry motion, and CT-simulator images for both static and moving objects		
d. Understands and competently assesses the quality of images produced by CT-simulators in any mode of operation and image reconstruction, and is able to discuss the impact of image artifacts and distortion on treatment planning		
e. Understands the connectivity requirements of a CT simulator to other computer systems that form part of a modern radiation therapy treatment process, including being familiar with Internet and DICOM-RT image data transfer protocols		
<b>Computed Tomography (CT) Simulators – CT Protocols</b>		
a. Demonstrates an understanding of the following parameters, their typical values, and how they are combined in CT protocols: slice thickness, pitch, kV, mAs, FOV, and scan length		
b. Demonstrates an understanding of how CT protocols consider multi-slice capabilities, tube heating, and maximum scan time		
c. Demonstrates an understanding of the relationship between image quality and patient dose from examination		

d. Demonstrates an understanding of the need to define dose-optimized imaging protocols for various body parts and sizes of patient		
e. Demonstrates an understanding of image artifacts that may arise in CT images, while being able to identify their causes and assess or mitigate their impact on radiation treatment planning		
f. Understands the different imaging protocols used in tumor motion management (e.g., voluntary breath hold, active breathing control, shallow breathing by compression, free breathing helical CT, 4D-CT)		
g. Understands the different CT image acquisition modes available with a modern CT simulator (e.g., prospective, retrospective, cine, helical, 4D, and image sorting based on breathing phase and breathing amplitude)		
<b>Magnetic Resonance Imaging (MRI) - General</b>		
a. Demonstrates an understanding of the basic imaging principles behind MRI		
b. Compares the treatment planning-related advantages and limitations of MRI with those of CT		
c. Demonstrates an understanding of the role of MRI for radiation therapy applications, providing examples		
<b>Magnetic Resonance Imaging (MRI) - QA</b>		
a. Demonstrates an understanding of the quality assurance processes and frequencies of checks for MR simulators (e.g., image quality, image integrity, safety and mechanical checks, network connectivity)		
<b>Ultrasound (US) - General</b>		
a. Demonstrates an understanding of the basic imaging principles behind US imaging		
b. Demonstrates an understanding of the role of US in external beam and brachytherapy treatments using trans-rectal as opposed to trans-abdominal probes, providing examples		
<b>Ultrasound (US) - QA</b>		
a. Describes methods for QA of US imaging probes prior to clinical uses in procedures such		

as prostate implants and prostate external beam therapy		
<b>Positron Emission Tomography (PET) - General</b>		
b. Demonstrates an understanding of the basic imaging principles behind PET		
c. Compares the advantages and limitations of PET with those of CT for treatment planning		
d. Demonstrates an understanding of the role of PET for radiation therapy applications, providing examples		
<b>Positron Emission Tomography (PET) - QA</b>		
a. Demonstrates an understanding of the quality assurance processes and frequencies of checks for PET-CT simulators (e.g., image quality, image integrity, safety and mechanical checks, network connectivity)		
<b>SPECT - General</b>		
a. Demonstrates an understanding of the basic imaging principles behind SPECT		
b. Describes the comparative advantages and limitations for treatment planning of SPECT and CT		
c. Demonstrates an understanding of the role of SPECT for external beam and radiopharmaceutical therapy applications, providing examples		
<b>Informatics</b>		
a. Uses information technology to retrieve and store patient demographic, examination, and image information		
b. Understands how image processing is used to create radiographic images for display presentation and depict 3D structures in CT and MR		
c. Uses information technology to investigate clinical, technical, and regulatory questions		
d. Uses and understands common information systems used in radiation oncology (e.g., record and verify, electronic medical records, image handling)		
e. Demonstrates an understanding of the various methods of data transfer, storage, and security, including:		

i. PACS		
ii. DICOM		
iii. DICOM in radiation therapy (DICOM-RT)		
iv. Health Level 7 (HL7)		
v. Integrating the Healthcare Enterprise (IHE)		
vi. IHE Radiation Oncology (IHE-RO)		
f. Understands the roles of physics and information technology staff, including their work in network integration and maintenance		
<b>Image Registration/Fusion</b>		
a. Describes the rationale behind and the advantages/challenges of image registration and image fusion		
b. Defines the image features on which registration can be based (e.g., landmarks, segments, intensities)		
c. Defines the different forms of registration (e.g., rigid, affine, deformable) and Describes their advantages and limitations		
d. Defines similarity metrics used to assess quality of registration (e.g., squared intensity differences, cross-correlation, mutual information)		
e. Describes how to commission imaging modalities such as MRI, PET-CT, and diagnostic CT for the purpose of image registration to a radiation oncology planning CT		
f. Describes issues associated with the transfer of images (e.g., connectivity, image dataset integrity)		
g. Describes issues associated with patient positioning (e.g., bore size, couch top, lasers, compatibility of immobilization devices, differences in patient position/ organ filling, motion)		
h. Describes issues associated with the choice of image acquisition technique (e.g., length of scan, slice thickness, FOV, kV, mAs)		
<b>Imaging Tests</b>		
a. Describes the tests that would be performed to ensure that the imported image data are		

correct		
b. Demonstrates that images can be imported from CT, MR, and PET or PET/CT scanners		
c. Demonstrates that the above imaging sets can be accurately fused with the primary treatment planning image set		
d. Describes the different image fusion algorithms available on a treatment-planning system (e.g., CT-CT, CT-MR, CT-PET)		
<b>On-Board MV and kV Imaging - General</b>		
a. Describes the different detector technologies that have been used for on-board MV and kV imaging		
b. Describes the imaging dose associated with on-board MV and kV imaging technologies		
c. Understands and performs the different measures of radiographic image quality as part of the routine duties		
<b>On-Board MV and kV Imaging - QA</b>		
a. Understands the QA processes and frequencies of checks for on-board MV and kV imaging, including cone-beam CT (e.g., image quality, image integrity, safety and mechanical checks, network connectivity, imaging dose, and localization software, isocenter calibration)		
b. Performs the above QA checks as part of the routine duties		
<b>Proton Therapy - Basics</b>		
a. Demonstrates an understanding of the theory of operation of proton accelerators currently used in radiation oncology treatment (e.g., synchrotrons and cyclotrons) and their limitations		
b. Demonstrates an understanding of proton percent depth dose in tissue and other media and proton ranges for different energies, e.g., stopping and scattering power and range		
c. Demonstrates an understanding of potential dose deposition uncertainties in proton therapy		
<b>Proton Therapy – Radiobiology</b>		

a. Demonstrates an understanding of the impact of the proton beam quality (e.g., linear energy transfer [LET]) on the relative biological effectiveness (RBE)		