Clinical Rotation 1: PHYS 701
Fall (3rd Week of August – 3rd Week of February)
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 external beam modalities (Megavoltage photons, electrons, superficial x-rays) including equipment selection, radiation protection, acceptance/commissioning, calibration and quality assurance. Theoretical basis and use of the various detectors and dosimeters associated with external beam modalities

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 first six months of the certificate program and consists of rotations through areas of external beam radiation therapy physics under the supervision of Board Certified Medical Physicists at one of the participating cancer centers. The course also includes assigned reading on the various aspects of external beam radiation therapy and ethics and professionalism. Objectives are established at the commencement of the course. The Resident will be assigned to one of the participating centers for this 6-month course. 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. Megavoltage (MV) photons and electrons (linear accelerators, tomotherapy unit, cyberknife), kilovoltage, and/or superficial x-rays. Note: The clinical site will have at least one type of x-ray therapy unit for hands on QC training and activities. Hands on QC training and activities on the other types of x-ray therapy units not available at the Resident's current clinical site will occur during subsequent 6 Month rotations at the other clinical sites that have the equipment.

A. Ethics and professionalism (Refs. 8, 9, and 10) – 2 Weeks
The topics listed below will be covered by the resident through the online modules and at the Resident sessions and Seminars. The resident will complete the modules and associated tests available on the following website: http://www.aapm.org/education/onlinemodules.asp

A. Attributes of Professions and Professionalism.
B. Physician/Patient/Colleague Relationships.
C. Personal Behavior and Employee Relationships.
D. Conflicts of Interest.
E. Ethics of Research.
F. Human Subjects Research.
G. Research with Animals.
H. Relationships with Vendors.
I. Publication Ethics.
J. Ethics of Education: Teacher and student.

B. Equipment Selection (Refs. 1 & 2) – 3 Weeks
1. Clinical radiation equipment and how it works
2. Performance specification
3. Feature comparison
4. Mechanical/architectural considerations
5. Performance test design

B. Patient Safety – 1 Weeks
1. Mechanical

        a. Blocks and trays
        b. Patient couch
        c. Gantry–patient collision
        d. Accessories
    2. Electrical
    3. Ozone
    4. Cerrobend

C. Acceptance/commissioning (Refs. 1 & 2) – 4 Weeks
    1. Mechanical, safety, and radiation tests
    2. Treatment planning data

D. Calibration – 4 Weeks
    1. Instrumentation and phantoms
    2. Photons (protocols: AAPM TG 51 and 61)
    3. Electrons (protocols: AAPM TG 51, 25 and 70)

E. Quality Assurance Activities (Refs. 1 & 2) – Ongoing
    1. Daily
    2. Weekly and/or monthly
    3. Annual
    4. Recommendations (AAPM TG 40)

F. Informatics (3 weeks)

II. Detectors and dosimeters associated with external beam modalities – 2 Weeks:
    1. Ionization chambers:
        a. Cylindrical
        b. Parallel-plate
    2. TLD and OSLD.
    3. Diodes.
    4. Film (silver bromide, radio chromic).
    5. MOSFET detectors.

Residents are also expected to read the Professional, Educational, and Science Policies on the AAPM website: http://www.aapm.org/org/policies/policy.asp?type=PP, and attend the Medical Physics Resident Sessions and Seminars on Leadership.

IV. Introduction to Treatment Planning and Special Projects (Ref. 1) – 4 Weeks
    A. Introductory knowledge and hands on experience in clinical treatment planning for external beam radiotherapy. Residents are expected to know basic anatomy.
    B. Special clinical projects related to external beam radiotherapy.

2. Student Learning Outcomes & Competency Evaluation Metrics

All of the outcomes listed in Appendix 1 of Clinical Rotation 1 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 ≥ 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 first 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:
The prerequisite for this course will be admission into the Medical Physics Residency Program at SDSU, which requires an M.S. or Ph.D. degree from a CAMPEP accredited Medical Physics Program including courses equivalent to the following.
Physics 560, 565, 567, 670A, 670B, 672A, and 672B.

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 (References)

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 Residents, by E. B. Podgorsak. International Atomic Energy Agency (IAEA), Vienna, Austria. Date Published 2005. PDF available for free download at: 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 Physics of Radiation Therapy, Khan, Faiz M. 4th Edition. Copyright ©2010 Lippincott Williams & Wilkins.

4. AAPM TG-25 Khan, F. M., K. P. Doppke, K. R. Hogstrom, G. J. Kutcher, R. Nath, S. C. Prasad, J. A. Purdy, M. Rozenfeld, and B. L. Werner. (1991). "Clinical electron-beam dosimetry: Report of AAPM Radiation Therapy Committee Task Group No. 25." Med Phys 18(1):73–109. Also available as AAPM Report No. 32.

5. AAPM TG-70 *Gerbi et al.*, (2009) "Recommendations for clinical electron beam dosimetry: Supplement to the recommendations of Task Group 25," Medical Physics, Vol. 36, No. 7.

6. AAPM TG-40 Kutcher, G. J., L. Coia, M. Gillin, W. F. Hanson, S. Leibel, R. J. Morton, J. R. Palta, J. A. Purdy, L. E. Reinstein, G. K. Svensson, M. Weller, and L. Wingfield. (1994). Comprehensive QA for radiation oncology: Report of AAPM Radiation Therapy Committee Task Group 40." Med Phys 21(4):581–618. Also available as AAPM Report No. 46.

7. AAPM TG-51 Almond, P. R., P. J. Biggs, B. M. Coursey, W. F. Hanson, M. Saiful Huq, R. Nath, and D. W. O. Rogers. (1999). "AAPM's TG-51 protocol for clinical reference dosimetry of high-energy photon and electron beams." Med Phys 26(9):1847–1870. Also available as AAPM Report No. 67.

8. AAPM TG-61 Ma, C.-M., C. W. Coffey, L. A. DeWerd, C. Liu, R. Nath, S. M. Seltzer, and J. P. Seuntjens. (2001). "AAPM protocol for 40–300 kV x-ray beam dosimetry in radiotherapy and radiobiology." Med Phys 28(6):868–893. Also available as AAPM Report No. 76.

9. AAPM TG-109 Serago, CF et al., "Code of Ethics for the American Association of Physicists in Medicine: report of Task Group 109." Med Phys 2009 Jan; 36(1):213-23.

10. ABR/ACR/RSNA/AAPM/ASTRO/ARR/ARS, Online Modules on Ethics and Professionalism. Retrieved May 31, 2012, from http://www.aapm.org/education/onlinemodules.asp

11. Professional, Educational, and Science Policies on the AAPM website: http://www.aapm.org/org/policies/policy.asp?type=PP.

12. NCRP Report 151, Structural Shielding Design and Evaluation for Megavoltage X and Gamma-Ray Radiotherapy Facilities (Dec 2005).

13. NCRP Report 116, Limitation of Exposure to Ionizing Radiation (1993).

14. NCRP Report 107, Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel (1990).

15. NCRP Report 40, Protection Against Radiation from Brachytherapy Sources (1972).

16. NCCN guidelines for treatment of cancer by 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 preforming 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.

RADIATION ONCOLOGY RESIDENCY PROGRAM
Competency Evaluation of Resident

Resident's Name:	
Rotation:	PHYS 701: Clinical Rotation 1
Inclusive dates of rotation:	
Director or Associate Director:	

Competency Assessment Scheme:

1. Unsatisfactory
   - Performance/Knowledge is below standard
2. Needs Improvement
   - Performance/Knowledge is below standards in certain areas and improvement is needed
3. Meets Expectations
   - Performance/knowledge that consistently meets high standards of competency
4. Above Expectations
   - Performance/Knowledge exceeds expectations
   - Performance/Knowledge is consistently high quality
5. Outstanding
   - Performance/Knowledge is exceptional and consistently superior

Evaluation criteria	Competency (from 1 – 5)	Explanatory Notes & Mentor Signature
Ethics and Professionalism Resident shall provide the certificate of completion for each module below available from: http://www.aapm.org/education/onlinemodules.asp		
a. Attributes of Professions and Professionalism		
b. Physician/Patient/Colleague Relationships		
c. Personal Behavior and Employee Relationships		
d. Conflicts of Interest		
e. Ethics of Research		
f. Human Subjects Research		
g. Research with Animals		

h. Relationships with Vendors		
i. Publication Ethics		
j. Ethics of Education: Teacher and student		
Leadership		
a. Attended resident session and/or Medical Physics Seminar on Leadership		
Equipment selection		
a. Understands theory of operation of megavoltage electron and proton accelerators currently used in radiation oncology treatment and their limitations		
b. Understands major subsystems and uses of cobalt units		
c. Understands major subsystems and components of megavoltage accelerators		
d. Knows the steps required to select a new megavoltage unit for use in radiation oncology on the basis of an understanding of performance specifications and features comparisons		
e. Knows the mechanical and architectural considerations when installing a new particle accelerator in both new and existing vaults (with discussion addressing heating, ventilation, and air conditioning [HVAC] openings, cabling for communication and dosimetry systems, electrical ports, plumbing, and skyshine)		
Patient Safety		
1. General		
a. Understands the principles behind the development of a general patient and staff safety management program within the hospital		
b. Describes the physicist's role in developing and overseeing an overall quality assurance program for both equipment and procedures, including a discussion of allocation and management of resources necessary to carry out these tasks, incorporation of tools and techniques into these tasks, and inclusion		

of various groups within the structure of the radiation oncology department		
c. Describes the principles and rationale of TJC Universal Protocol as well as the use of pre-procedure verification and time-outs for the prevention of treatment errors		
d. Describes internal, voluntary, and mandatory incident reporting systems and the role of root cause analysis (RCA) as a tool for continuous quality improvement		
e. Describes the concept of a failure mode and effect analysis (FMEA), design and implementation of an FMEA, and how to use the results of such an analysis to prevent errors and minimize risks to patients and staff		
f. Describes charting systems for the prescription, delivery, and recording of treatment information, standardization of such systems, and the use of such systems within a record and verify electronic medical record system		
g. Describes mechanisms for independent checking of treatment information		
2. Equipment		
a. Describes the implementation of an effective set of equipment operating procedures that would include preventative maintenance and repair, keeping of maintenance and repair records, emergency procedures, and systematic inspection of interlock systems		
b. Describes the development of a program to prevent mechanical injury caused by the machine or accessory equipment, with consideration of the need for visual and audio contact with the patient while the patient is under treatment		
c. Understands potential patient safety hazards related to the use of blocks, block trays, wedges, and other ancillary treatment devices and accessories as well as mechanisms to minimize these risks		
d. Understands potential patient safety hazards posed by patient support and immobilization systems, as well as mechanisms to minimize these risks		
e. Understands potential patient safety hazards of gantry–patient collision as well as mechanisms to minimize this risk		
3. Other patient/staff safety issues		
a. Understands potential electrical hazards affecting patients and staff		

b. Understands the potential hazards to patients and staff posed by strong magnetic fields		
c. Understands the mechanisms of ozone production and related potential hazards to patients and staff		
d. Understands potential hazards to patients and staff arising from the use of cerrobend		
Acceptance/commissioning		
a. Competently performs the mechanical, safety, and radiation tests required during accelerator acceptance and commissioning		
b. Understands the process for defining the treatment beam isocenter of a gantry-based particle accelerator and its relation to the gantry's mechanical isocenter and any on-board imaging isocenters		
c. Explains and/or performs treatment unit head radiation leakage and shielding adequacy tests		
d. Independently sets up and performs water tank scans for photon and electron beam measurements that calibrate and characterize those external beams to facilitate computerized treatment planning and hand calculations of radiation dose to a point		
e. Analyzes water tank scans and understands the results of these scans, including typically accepted tolerances for each test performed		
f. Understands acceptance, commissioning, and on-going annual QA requirements for radiation treatment planning system modules dealing with external beam treatments		
Calibration		
a. Demonstrates an understanding of and an ability to use the instrumentation (e.g., theory of operation, limitations) and protocols that may be employed in calibrating of radiation treatment beams of energy in the megavoltage range		
b. Understands how and why phantoms are used for physical measurements		
c. Understands the correction factors used for photon and electron calibration measurements		
d. Competently calibrates megavoltage external beams of photons and electrons using a recognized national or international protocol		

(e.g., TG-51)		
Quality Assurance Activities		
a. Understands the pertinent recommendations for quality assurance of linacs used in radiation therapy		
b. Understands in-house quality assurance documentation and procedures		
c. Competently performs routine (daily/weekly/monthly/annual) quality assurance tests of external beam treatment units		
d. Competently analyzes routine quality assurance tests of external beam treatment units		
e. Understands the basis of accepted tolerances for routine quality assurance tests performed on treatment units and of required actions should any of the checks fall out of tolerance		
f. Understands external beam treatment unit malfunction management		
g. Competently performs end-to-end checks of patient treatment plans using phan- tom images and data		
h. Understands the connectivity requirements of external beam treatment units to treatment simulators, on-board imaging systems, record and verify systems, and electronic medical records systems		
Detectors and dosimeters associated with external beam modalities		
a. Understands absorbed-dose calculation and measurement		
b. Understands Bragg–Gray, Spencer–Attix, and Burlin cavity theories		
c. Understands dosimeter design considerations (e.g., detection mechanism, sensitivity, size, shape, thickness of sensitive volume and wall, materials, energy dependence, detector/phantom media matching, dose and dose rate range, stability of reading)		
1. Ionization chambers		
a) Understands design considerations pertaining to cylindrical ionization chambers, including size, shape, materials, and electrical characteristics		

b) Understands design considerations pertaining to parallel-plate ionization chambers, including size, shape, materials, electrical characteristics, and use for measuring dose in the buildup region		
c) Understands the advantages and disadvantages of each ionization chamber design, including detector limitations		
d) Understands ionization chamber measurement techniques involving instruments such as electrometers, operational amplifiers, and triaxial cables and connections		
e) Performs acceptance testing for ionization chamber and electrometer involving measurements of leakage and evaluation of relevance, polarity effects, and stem effects		
f) Performs ionization chamber measurements using Farmer, parallel-plate, and scanning chambers, as well as large-volume survey ionization chambers		
g) Understands ion chamber correction factors, including P_{TP}, P_{pol}, P_{elec}, P_{ion}, P_{wall}, P_{grad}, P_{fl}, and P_{cel}		
h) Calculates corrected charge readings for ion chamber measurement using TG-51 formalism		
i) Understands the ion chamber calibration process on the basis of NIST/ADCL		
j) Understands design and characteristics of monitor chambers		
2. TLD/OSLD		
a) Understands the physical mechanisms involved in the process of radiation detection and readout using TLDs or OSLDs		
b) If possible, performs TLD or OSLD measurements and readout (including calibration) using standard irradiation		
c) Understands the method and rationale for TLD annealing		
d) Discusses the advantages and disadvantages of TLDs or OSLDs		
3. Diodes		
a) Understands the physical mechanisms involved in radiation detection and readout using semiconductor dosimeters		
b) If possible, performs diode measurements that include investigation of factors such as angular and dose rate dependence and temperature sensitivity		

c) Discusses the advantages and disadvantages of diodes, including their inherent limitations		
4. Film (silver bromide, radio chromic)		
a) Understands the physical mechanisms involved in radiation detection and measurement using film, including measurement of the optical density and its characteristics as a function of absorbed dose, and film's dependence on radiation energy, handling, and processor conditions		
b) If possible, performs film dosimetry including creation of calibration curve		
C) Discusses the advantages and disadvantages of using film, including its inherent limitations		
5. MOSFET detectors		
a) Understands the physical mechanisms involved in radiation detection and readout using MOSFET dosimeters		
b) Discusses the advantages and disadvantages of using MOSFETs, including their inherent limitations		
Informatics		
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		
g. 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		
h. Describes issues associated with the transfer of images (e.g., connectivity, image dataset integrity)		
i. Describes accuracy checks for the following output devices:		
i. Printers		
ii. Record and verify systems		
iii. DICOM output		
Introduction to Treatment Planning and Special Projects		
a. Introductory knowledge, observation and/or hands on experience in clinical treatment planning for external beam radiotherapy. Residents are expected to know basic anatomy.		
b. A special clinical project related to external beam radiotherapy		