

**University of North Carolina Hospitals**

**Radiation Therapy Program**

**Student Handbook**

**2021-2022**

Reviewed and Revised July 2021 for the Academic Year 2021-2022

## Contents

Program Director Contact Information .....	5
2021-2022 Program Development Committee .....	6
Introduction .....	7
Mission .....	8
Program Description .....	8
Program Purpose.....	9
Non-Discrimination .....	9
Advising .....	9
JRCERT Program Accreditation.....	10
Program Effectiveness Data .....	11
The Sponsoring Institution .....	12
Agreement to Adhere to the Program’s Policies and Procedures.....	13
Policies Governing Student Continuation and Promotion .....	13
Corrective Action and Grievance Procedure: Student Right to Appeal (Due Process).....	13
Workplace Hazards, Harassment, Communicable Diseases, and Substance Abuse .....	14
Grades .....	15
Code of Conduct.....	15
Dismissal from the Program .....	16
Readmission .....	17
Use of Illegal Drugs.....	17
Health Program .....	17
Holidays.....	17
Sick Time .....	18
Inclement Weather Policy .....	18
Dress Code.....	19
Disability, Illness, Pregnancy .....	19
Student Clinical Hours .....	19
Emergency/Safety Orientation.....	20
Attendance.....	20
Vacation .....	21
Health Insurance – Emergency Situation .....	21

Radiation Monitoring .....	21
Direct Supervision Policy .....	22
Classroom Behavior/Code of Conduct .....	22
UNC Hospitals Radiation Therapy Program Pregnancy Policy.....	22
Appendix B .....	25
Appendix C .....	28
Safety Procedures .....	34
Incident Reports .....	34
Health Status .....	34
Student Maltreatment .....	35
Immunizations, Background Check and Drug screening .....	36
Graduation Requirements/National ARRT Certification Examination.....	37
Release of Student Records.....	37
UNC Hospitals Radiation Therapy Program Curriculum .....	39
Courses.....	39
Course Sequence.....	42
RTT 500 Foundations of Radiation Therapy .....	43
Weekly Writing Assignments - Fall .....	53
Weekly Writing Assignments – Spring.....	55
RTT 595 Research Methodology and Design Statistics I.....	59
RTT 94 Radiation Dosimetry I .....	64
RTT 531 Clinical Education in Radiation Therapy I .....	70
CLINICAL TIME SHEET .....	75
Self Evaluation .....	76
Weekly Evaluation.....	77
Evaluation of Clinical Environment .....	78
Overall Evaluation .....	79
Treatment Competency Evaluation.....	81
CT Simulation Competency Evaluation .....	83
2021-2022 Clinical Competency Requirements .....	85
RTT 596 Research Methodology and Design Statistics II.....	87
RTT 550 Radiation Oncology .....	89

RTT 92 Medical Radiation Therapy Physics II .....	94
RTT 97 The Radiobiology of Radiotherapy .....	109
RTT 532 Clinical Education in Radiation Therapy II .....	118
RTT 560 Radiation Safety and Protection.....	120
RTT 600 Seminars in Radiation Oncology.....	125
RTT 533 Clinical Education in Radiation Therapy III .....	127
Facilities and Equipment .....	129
Faculty and Staff.....	129
How to Apply.....	131
Tuition and Fees .....	131
Transfer Students/Credits .....	131
Program Physical Requirements .....	131
University of North Carolina (UNC) Hospitals .....	145
Radiation Therapy Program (JRCERT 0906).....	145
Assessment Plan: Analysis and Actions .....	145

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## **2021-2022 Program Development Committee**

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Radiation Therapist

Department of Radiation Oncology

Duke University Hospital

4 UNC Radiation Therapy Students

## **Introduction**

The following general information regarding policies, procedures, regulations, and schedules has been prepared for the student entering the UNC Hospitals Radiation Therapy Program. The student should familiarize him/herself with these policies, procedures, etc., ask questions for better understanding, and abide by them to the best of his/her ability.

## **Mission**

The UNC Hospitals Radiation Therapy Program will prepare competent, educated, and professional entry-level radiation therapists who will participate in scholarly activity and enhance overall patient care. (JRCERT Standard 6).

## **Goals & Student Learning Outcomes (JRCERT Standard 6.1)**

Goal 1: Students will be clinically competent.

Student Learning Outcome: Students will demonstrate acquisition of correct CT simulation skills.

Student Learning Outcome: Students will evidence competency in treatment.

Goal 2: Students will demonstrate effective communication skills.

Student Learning Outcome: Students will effectively communicate with patients, therapists, faculty, and staff.

Student Learning Outcome: Students will write at a proficient level by graduation.

Goal 3: Students will develop critical thinking skills.

Student Learning Outcome: Students apply didactic concepts and information into the clinical setting.

Student Learning Outcome: Students will conceptualize current patient safety radiation therapy Lean A3 engineering principles.

Goal 4: Students will grow and develop professionally.

Student Learning Outcome: Students will demonstrate professional behaviors.

Student Learning Outcome: Students will participate in continuing education.

## **Program Description**

The radiation therapist is a vital and essential member of the radiation oncology team. The UNC Hospitals Radiation Therapy Program is located in the UNC Department of Radiation Oncology in Chapel Hill, NC. The UNC Department of Radiation Oncology was formed in 1987 from the UNC Division of Radiation Therapy. The UNC Division of Radiation Therapy began in 1969 with the purchase of a Cobalt<sup>60</sup> unit.

The program course material and practicum covers radiation protection, radiation physics, dose calculations, external beam treatment, brachytherapy, quality assurance, medical imaging/anatomy, clinical radiation oncology, and radiobiology. Clinical practicum includes CT simulation, patient preparation, chart reviews, dose calculations, record and verify system data entry, external beam treatment (3D, IMRT, TomoTherapy, CyberKnife), and treatment machine

quality assurance. Conference attendance, oral and written reports, and special projects are also part of the curriculum.

### **Program Purpose**

The purpose of the UNC Hospitals Radiation Therapy Program is to fulfill its mission and goals through the completion of stated objectives. The program provides superior quality higher education with flexibility to accommodate expanding technological growth in radiation oncology and radiation therapy created knowledge and clinical practice. The program maintains relationships with other educational programs for support and collaboration to improve radiation therapy education.

The student has the responsibility to make the most of available educational experiences, and once enrolled, is obligated to abide by the policies and procedures of the UNC Hospitals Radiation Therapy Program.

### **Non-Discrimination**

The program, as with UNC Hospitals policy (<http://www.unchealthcare.org/site/humanresources/careers/why/code/>), does not discriminate in student recruitment or admissions practices on the grounds of race, color, religion, gender, age, disability, national origin, or any other protected class (JRCERT Standard 1). If the student has a question/concern about discrimination, he/she may contact the UNC Department of Radiation Oncology Administrative Director at (984) 974-8450.

### **Advising**

Being housed within a Carnegie Level 1 Research Institution allows the UNC Hospitals Radiation Therapy Program to offer the student excellent academic, behavioral, and clinical advisement.

The UNC Hospitals Radiation Therapy program director and didactic and clinical instructors are available for recruitment and pre-admissions advising as necessary. The admissions procedure for the program includes an extensive advising session. The enrolled student has an orientation advising session at the beginning of each semester.

The program director and didactic and clinical instructors are also available for individual academic, behavioral, and/or clinical advisement as needed. Each didactic instructor provides mid-semester feedback to the radiation therapy student. Additionally, the program director meets both mid-semester and post-semester with each UNC Hospitals radiation therapy student to discuss his/her progress through the curriculum. (JRCERT Standard 4.8).

Because the radiation therapy program is housed within the UNC Department of Radiation Oncology, the program director communicates with the student almost daily. This type of continuous communication allows for both formal and informal feedback between the student and the program director, thus allowing a continuous type of advising between the program director and the student on academic, behavioral, and/or clinical issues. Furthermore, each clinical instructor is given anonymous student feedback by the program director.

Additionally, each UNC Hospitals radiation therapy student has access to the UNC-Chapel Hill Libraries (5, including a dedicated Health Sciences Library) to access journals/books and use the learning resources. The UNC Hospitals student also has access to the UNC Libraries via departmental Internet (JRCERT Standard 2). Moreover, for a fee of ~\$120/year, the student has access to the student recreational center if desired.

Finally, academic, behavioral, and/or clinical advisement is also offered by UNC School of Medicine faculty. As an external advisement measure, the UNC Hospitals Nuclear Medicine Program Director is available as a student advisor for any academic, behavioral, and/or clinical issues.

### **JRCERT Program Accreditation**

The program is recognized by the Joint Review Committee on Education in Radiologic Technology (JRCERT). A copy of the Standards for an Accredited Educational Program in Radiation Therapy is available online (<http://jrcert.org/programs-faculty/jrcert-standards/>) and from the program director (JRCERT Standard 1.5). Any questions about the program may be forwarded to either the program director or the JRCERT. The JRCERT's contact information is (JRCERT Standard 1.5):

JRCERT  
20 N. Wacker Drive  
Suite 2850  
Chicago, IL 60606-2901  
Phone: (312) 704-5300  
E-mail: [mail@jrcert.org](mailto:mail@jrcert.org)

In addition to being in this student handbook, the UNC Hospitals Radiation Therapy Program Effectiveness Data is also available via the JRCERT's Web site, [jrcert.org](http://jrcert.org).

The radiation therapy program effectiveness data is also on the UNC Hospitals Radiation Therapy Program's Web site ([med.unc.edu/radonc/pro/education/therapy](http://med.unc.edu/radonc/pro/education/therapy)).

### Program Effectiveness Data

Outcome	Measurement Tool	Benchmark	Timeframe	Responsible Party	Results	Metric	Action Plan
Attrition	Program completion rate	50%	Annual	Program Director (reported annually to the advisory committee)	2020: 0% (0/4) 2019: 0% (0/4) 2018: 0% (0/4) 2017: 0% (0/4) 2016: 25% (1/4)	Program benchmark was met.	Continue as is.
Pass Rate	Credentialing examination pass rate	100%	5-year average pass rate (at 1 <sup>st</sup> attempt within 6 months of graduation)	Program Director (reported annually to the advisory committee)	2020: 100% 2019: 100% 2018: 100% 2017: 100% 2016: 100%	Program benchmark was met.	Continue as is.

Employment	Job placement rate	100%	5-year average job placement rate (within 6 months of graduation)	Program Director (reported annually to the advisory committee)	2020: 100% 2019: 100% 2018: 100% 2017: 100% 2016: 100%	Program benchmark was met.	Continue as is.
Graduate Satisfaction	Graduate survey	At least a 4 on a 5 point scale	Annual	Program Director (reported annually to the advisory committee)	2020: 4.6/5 2019: 4.6/5 2018: 4.5/5 2017: 4.5/5 2016: 4.5/5	Program benchmark was met.	Continue as is.
Employer Satisfaction	Employer survey	At least a 4 on a 5 point scale	Annual	Program Director (reported annually to the advisory committee)	2020: 4.5/5 2019: 4.5/5 2018: 4.5/5 2017: 4.5/5 2016: 4.4/5	Program benchmark was met.	Continue as is.

**The Sponsoring Institution**

UNC Hospitals sponsors the radiation therapy program. All program functions, including administrative structure (organizational structure and administrative support, as well as didactic and clinical faculty, faculty continuing education, and clerical support services) are coordinated and administered by UNC Hospitals and UNC School of Medicine faculty and staff. Moreover, the education program has a dedicated didactic classroom. The program reviews and maintains student learning resources and student services as would be expected at a Carnegie Level 1 Research Institution. Finally, the UNC Hospitals clinical radiation therapy setting is recognized

by the JRCERT. The education program has two external clinical sites, Rex Healthcare and Duke University Hospital, also recognized by the JRCERT.

The UNC Department of Radiation Oncology has the following student groups/education programs: 1) UNC Hospitals radiation therapy students, 2) UNC Hospitals medical dosimetry students, 3) UNC Hospitals medical physics residents, and 4) UNC Hospitals radiation oncology medical residents, and the following visiting students: 1) UNC radiologic science students, 2) UNC nursing students, and 3) UNC medical students. The UNC Department of Radiation Oncology has a tripartite mission of clinical care, research, and education. This mission correlates with the UNC School of Medicine and the greater UNC Hospitals. UNC Hospitals, UNC-Chapel Hill, and its programs are all physically located on the contiguous UNC Hospitals/UNC-Chapel Hill campus.

Professional liability insurance coverage is taken care of by a group policy through UNC Hospitals.

### **Agreement to Adhere to the Program's Policies and Procedures**

The student indicates acceptance of these policies and procedures by enrollment in the UNC Hospitals Radiation Therapy Program. The program reserves the right to change these policies and procedures when in the best interest of the program. Upon implementation, the student will receive written notification of any changes (JRCERT Standard 1). It should be noted that during orientation there is a review of the student handbook. Each student signs and dates a form that states that he/she understands all policies and procedures within the UNC Hospitals Radiation Therapy Program student handbook.

### **Policies Governing Student Continuation and Promotion**

The student is responsible for observing the policies and procedures of the UNC Hospitals Radiation Therapy Program as they are announced in this document. The program director will assist the student with the details of his/her program and/or academic problems. This assistance does not relieve the student of his/her individual responsibility for meeting the requirements and observing the regulations of UNC Hospitals, the UNC Department of Radiation Oncology, and the UNC Hospitals Radiation Therapy Program.

### **Corrective Action and Grievance Procedure: Student Right to Appeal (Due Process)**

The radiation therapy program director must address issues in which the student fails to follow therapy program curriculum guidelines or policies:

The issue will be adjudicated in the following manner:

- A) The program director will determine the necessary course of action and present it to the student.
- B) If formal discussion with the program director does not resolve the violation, misinterpretation, or inequitable application of any existing policy, procedure, or regulation, or other action issue to the student's satisfaction, the student has the right to submit a written appeal to the UNC Hospitals Radiation Therapy Program Development Committee within 10 working days following the initial date of the issue. The appeal will then be directed to the UNC Department of Radiation Oncology Administrative Director. If the issue is not resolved to the student's satisfaction, the student has 10 working days to submit a second written appeal to the Program Development Committee. The appeal will then be directed to the UNC Department of Radiation Oncology Associate Chair. If the issue is still not resolved to the student's satisfaction, the student has 10 working days to submit a third written appeal to the Development Committee. The final appeal will then be directed to a mediation committee, whose members are outside the UNC Department of Radiation Oncology. This committee consists of the following members: the UNC Nuclear Medicine Program Director, the UNC Nuclear Medicine Chair, and a UNC Nuclear Medicine student. This is the final appeal process for the student (JRCERT Standard 1.6).

The program also assesses current student and graduate evaluations/surveys for the general overall structure and function of the education program via specific questions through its course/faculty evaluations and graduate surveys. The program director, faculty, and staff are always available for comments/suggestions about any component of the education program that needs improvement. If for any reason a student feels he/she is not being heard, he/she should speak directly with the program director to make sure the request/suggestion/complaints has been communicated properly.

If the student wishes to contact the JRCERT regarding a situation, he/she may do so with the aforementioned information.

### **Workplace Hazards, Harassment, Communicable Diseases, and Substance Abuse**

In the event that the student is concerned with workplace hazards, harassment, communicable diseases, or substance abuse, he/she should refer to institutional policies reviewed during program orientation and/or contact the program director immediately. The program director will work with the facility to ensure the safety of the student (JRCERT Standard 4.5).

## **Grades** (JRCERT Standard 1.9)

To be eligible for a certificate in medical dosimetry, the student must satisfactorily pass all courses in the UNC Hospitals Medical Dosimetry Program curriculum. If the student's academic and/or clinical performance is considered unsatisfactory, the student will be placed on formal probation. In order to remove the probationary status, the student must make at least 80% on subsequent assignments during the next semester and complete any remedial work/examinations as required by the didactic instructor and approved by the Program Development Committee. Should the probationary status go unremoved, the student will be dismissed from the program. To satisfactorily pass a course means that the student earns a grade of at least a C. To satisfactorily pass a course in which the student makes a C-, the student must complete any remedial work/examinations as required by the didactic instructor and approved by the Program Development Committee.

Any student making a grade of D in any one course will automatically be dismissed from the program.

If the student is dissatisfied with any didactic and/or clinical grade during the course of the year, he/she has the right to appeal. Please see the Corrective Action and Grievance Procedure: Student Right to Appeal (Due Process) section in this document.

The grading scale for all classes will be as follows (unless otherwise indicated in site-specific syllabi, linked in the table of contents and contained below):

97 and up	A+
93 – 97	A
90 – 93	A-
87 – 90	B+
83 – 87	B
80 – 83	B-
77 – 80	C+
73 – 77	C
70 – 73	C-
67 – 70	D+
63 - 67	D
Below 63	F

## **Code of Conduct**

Expulsion or suspension, or lesser sanctions, may result from the commission of any of the following offenses:

Academic cheating, including (but not limited to) unauthorized copying, collaboration, or use of notes/books on examinations, and plagiarism (defined as *the intentional representation of another person's words, thoughts, or ideas as one's own*).

For academic cheating, suspension is the normal sanction for the initial offense, unless the Program Development Committee determines that unusual mitigating circumstances justify a lesser sentence.

The furnishing of false information, with the intent to deceive, to members of the UNC Hospitals community who are acting in the exercise of their official duties, forgery, falsification, and/or fraudulent misuse of UNC Hospitals documents, records, or identification cards will result in expulsion from the program.

It is noted that a sanction against a student may also result in the student being dismissed from the program. For example, if a grade of D is given in a course in which the student has admitted cheating, he/she will be dismissed from the program.

Every student has the right to appeal any infraction of the Code of Conduct. Please see the [Corrective Action and Grievance Procedure: Student Right to Appeal \(Due Process\)](#) section in this document.

### **Dismissal from the Program**

In addition to academic ineligibility to complete the program, the student may be dismissed for inappropriate professional attitudes and/or actions, as described in the American Registry of Radiologic Technologists (ARRT) Code of Ethics and the American Society of Radiologic Technologists (ASRT) practice standards established by the profession. These standards are important professional standards for the student preparing to deliver a high standard of healthcare delivery and service.

A student may be judged unacceptable for continuation in the UNC Hospitals Radiation Therapy Program when he/she has displayed a lack of professionalism with respect to other students, patients, faculty, and/or staff.

The UNC Hospitals Radiation Therapy Program reserves the right to dismiss a student from the program when the student does not, in its judgment, demonstrate sufficient promise to justify continuation of study in the UNC Hospitals Radiation Therapy Program.

If the student is dismissed from the program, he/she has the right to appeal, as stated in this document.

## **Readmission**

A student who withdraws from the program must reapply and go through the admissions process again. No refunds are made after orientation is complete (JRCERT Standard 1.9).

## **Use of Illegal Drugs**

Students, faculty, and staff of UNC Hospitals are responsible, as citizens, for knowing about and complying with the provisions of North Carolina law that make it a crime to possess, sell, deliver, or manufacture those drugs designated collectively as “controlled substances” in Article 5 of Chapter 90 of the North Carolina General Statutes. Any member of the UNC Hospitals community who violates that law is subject both to prosecution and punishment by civil authorities and to disciplinary proceedings by the UNC Department of Radiation Oncology. Disciplinary proceedings against a student, faculty member, or staff member will be initiated when the alleged conduct is deemed to affect the interests of UNC Hospitals.

Before entry into the UNC Hospitals Radiation Therapy Education Program, the accepted student must pass a drug test .

## **Health Program**

Students in the UNC Hospitals Radiation Therapy Program are under the healthcare program of UNC Hospitals. It is mandatory that the student carry a hospitalization insurance policy to cover any necessary operations or special services that may be required during his/her education.

## **Holidays**

The student will not have class or clinical on hospital holidays: New Year’s Day, Martin Luther King Jr. Day, Memorial Day, 4<sup>th</sup> of July, Labor Day, day before Thanksgiving, Thanksgiving, day after Thanksgiving, Christmas Eve, Christmas, and day after Christmas. The student must be present on all other holidays unless preapproved by the program director.

## **Sick Time**

The student must contact the program director and/or clinical instructor in all cases if sick by 8:00 a.m. that morning. Any time missed by the student due to calling in sick must be made up. If the student misses class time, he/she is responsible to contact the instructor and make up missed information – notes, quizzes, or exams. If the student misses clinical rotations, he/she must make up time during scheduled breaks or come early/stay late (JRCERT Standard 1). The student may not exceed more than 40 hours/week or more than 10 hours in any day. If the student exceeds these time limits, he/she must do so voluntarily (JRCERT Standard 1).

Due to the nature of the program’s curriculum, class attendance and timeliness are mandatory, with the exception of student/family illness or attendance of professional meetings/seminars. These exceptions will constitute an excused absence and the student is to make up any missed didactic work. Class absences are excused only by the program director or didactic instructor; any absence regarding professional meetings/seminars must be approved in advance.

Excessive tardiness is subject to corrective discipline, in the form of probation and/or dismissal. Excessive tardiness is defined as more than 3 instances of lateness in a semester. After 4 instances, the student will be placed on formal probation. Any 5 instances in a semester will result in dismissal from the program.

In order to be fair and equitable to each student and the program, it is the policy of the program that the student cannot bank time before an absence. The student can, however, make up time after the absence.

## **Inclement Weather Policy**

If bad weather (snow, ice, flooding, tornado, earthquake, etc.) occurs on a clinical day, the student is responsible for finding out if the local university is closed. If it is closed due to hazardous road conditions, the student is excused from going to class/clinical, even though the Radiation Oncology department may be open. The student must write “Inclement Weather” on his/her time sheet, and this absence will be verified by the clinical instructor. If the local university is open, but the student cannot get to the clinical site, then he/she must make up the day.

Note: All unexcused “Inclement Weather” days must be made up.

## **Dress Code**

All clothing and jewelry must be consistent with professional/business dress standards applicable to the work responsibilities involved, and must be appropriate for reasonably anticipated public contact. The student should wear a white mid-length lab coat at all times. The student's clothes should be neatly pressed for a professional appearance. Males should also wear a tie. Dress shoes should also be worn; however, no open-toed dress shoes are allowed.

The student must wear his/her UNC Hospitals name badge each day. The identification badge must be worn so that the picture, name, and department are easily visible at all times.

Hair, including beards and mustaches, is to be clean, neatly groomed, and kept in such a way as not to interfere with student duties or safety. Hair that is longer than the collar on males, or longer than the shoulder on females, is to be pulled back and fastened to prevent contamination.

Fingernails are to be clean, trimmed, and extend no further than ¼" beyond the fingertips. Clear or conservative light-colored nail polish may be worn.

No visible tattoos are allowed. Piercings are limited to ears only (one set of earrings).

## **Disability, Illness, Pregnancy**

The program director will determine if a student may continue the program should illness or disability arise. The decision will be made on an individual basis, taking into account the nature and degree of the disability, as well as a physician's recommendation that the student may continue the program. Accommodations for disabilities as defined by federal (ADA) and state laws will be provided (JRCERT Standard 2.8).

If a student becomes pregnant while in the program, the pregnancy policy within this handbook will be followed.

The student must make up all missed class and clinic time. If the student is unable to complete assigned time commitments by the end of the program, she will not graduate until she has successfully completed didactic work and clinical rotations.

## **Student Clinical Hours**

Student clinical hours are 8:00 a.m. – 4:30 p.m. Monday, Wednesday, and Friday each week, with the exception of holidays (360 contact hours per semester/6 credit hours).

Hours may possibly vary depending upon the clinical rotation requirements. The student sometimes may need to remain in the clinic beyond the normal hours in order to complete an assignment related to his/her learning.

<b>Clinic Site</b>	<b>Phone Number</b>	<b>Clinical Instructors</b>
UNC Hospitals NC Cancer Hospital Dept. of Radiation Oncology 101 Manning Drive Chapel Hill, NC 27514-7512	(984) 784-5300	Dana LaChapelle, AS, RT(R)(T) Traci Leach, MS, RT(R)(T) UNC Registered Radiation Therapists
Duke University Hospital Dept. of Radiation Oncology 20 Duke Clinic Circle Durham, NC 27705	(919) 954-3096	Nelson Santana, BS, RTT) Duke Registered Radiation Therapist

### **Emergency/Safety Orientation**

During the initial program orientation, the student will participate in an emergency procedures/safety orientation specific to UNC Hospitals. These health and safety issues are completed before the student is allowed in the UNC Hospitals clinical areas. When the students begin their rotations at Duke University Hospital, orientations are done by the chief therapists to address quality and safety issues before the UNC student is allowed to proceed to the clinical areas. The policies and procedures include, but are not limited to, the following (JRCERT Standard 5):

Hazards: Fire, electrical/chemical emergencies

Emergency Preparedness

Medical Emergencies

HIPAA

Standard Precautions

### **Attendance**

The student must report to his/her assigned class or clinical rotation for the duration of the hours specified by the schedule, unless preapproved by the program director for absence or tardiness. If the student misses 5 days throughout the program, his/her clinical grade will be lowered one letter grade. If the student misses 6 or more days during the year, the student can be removed from the program.

The student is expected to report to the class/clinical area at the designated time. Tardiness is not considered responsible, professional behavior. Three late arrivals, each in excess of 10 minutes, will be considered the equivalent of one absence for grade determination. It is the student's responsibility to call the program director/clinical instructor prior to the beginning of the

class/clinical time period if he/she is going to be late. Failure to do this will result in 2 points being deducted from the final clinical grade for each infraction.

### **Vacation**

The student receives 5 days of vacation. He/she is allowed 1 personal day (i.e. for a wedding/funeral) and 2 interview days while in the program. The interview days require documentation and may only be taken during the spring or summer semesters.

The student is given release time to attend professional meetings/seminars. The student is responsible for his/her conference, travel, and hotel fees.

### **Health Insurance – Emergency Situation**

If the student has an emergency, he/she is to go to the local hospital emergency room or urgent care clinic.

### **Radiation Monitoring**

The student must wear a personnel monitoring device at all times in the clinic. Exposure reports will be available for review once processed. If a dose reading exceeds normal limits ( $\geq 0.125$  rem or  $\geq 1.25$  mSv per quarter) the student will be contacted by the UNC Radiation Safety Officer or program personnel (JRCERT Standard 5). In the event an accidental exposure occurs, the student must notify the program director regarding the incident. The program director will work with the Radiation Safety Officer and make a plan of action for the event. If the badge is lost, damaged, or the student has any other concerns, he/she should contact the program director.

If a student feels that he/she has received a high radiation dose exposure (exceeding normal limits of  $\geq 0.125$  rem or  $\geq 1.25$  mSv per quarter) for any reason, the student should immediately contact the program director. The student should not wait. An emergency reading will be done by UNC Radiation Safety.

UNC Hospitals badges are read quarterly. When the quarterly reports come to the UNC Department of Radiation Oncology, they are posted in the M and B level break rooms. It is each student's responsibility to look at and initial the report.

UNC Hospitals has a Radiation Safety department on site. If anyone has a high radiation reading, the UNC Radiation Safety department will notify the program director and student in writing and in person.

### **Direct Supervision Policy**

All procedures performed by a student while on a clinical rotation must be *directly supervised by a qualified practitioner*. This individual will receive the procedure in relation to the student's achievement, evaluate the condition of the patient in relation to the student's knowledge, be present during the procedure, and review and approve the procedure. All clinical work performed by a student must be checked prior to clinical implementation. Any time a student is having direct contact with a patient, facility personnel must be present (JRCERT Standard 5).

### **Classroom Behavior/Code of Conduct**

The classroom is a safe environment for the student. The focus will be on learning. Causing disruptions, harassment of other students, foul language, disrespect for others, or entertaining at someone else's expense will not be tolerated.

### **UNC Hospitals Radiation Therapy Program Pregnancy Policy**

The UNC Hospitals Radiation Therapy faculty recognize the basic premise of providing the pregnant student with the information to make an informed decision based on her individual needs and preferences (JRCERT 5). Thus, all female UNC Hospitals radiation therapy students are requested to read the following documents, contained in this policy.

1. NCRP Report #116, 1993, Section 10 "Protection of the Embryo-Fetus"
2. US Nuclear Regulatory Commission Regulatory Guide 8.13, Revision 3 December 1999, "Instruction Concerning Prenatal Radiation Exposure"

Further information on the fetal effects of radiation may be found in Bushong's radiographic physics book on pages 543-548 and pages 559-565 (Bushong, SC (2004)). Radiologic science for technologists: Physics, biology, & protection, 8<sup>th</sup> ed. St. Louis, MO: Elsevier Science/Mosby, Inc.)

Finally, UNC Hospitals Radiation Therapy faculty believe it is the responsibility of the pregnant student to advise her program director and clinical instructor voluntarily and in writing of her pregnancy and the estimated date of the baby's birth (delivery). Formal, voluntary notification (declaration of pregnancy) is the only means by which the clinical facility and the UNC Hospitals Radiation Therapy Program can ensure that the dose to the embryo-fetus is limited during the pregnancy (not to exceed 5 mSv (500 mrem)). In the absence of the voluntary, written disclosure, the student cannot be considered pregnant.

Therefore, at the beginning of the program, each UNC Hospitals Radiation Therapy female student will read the documents, have her questions answered to her satisfaction, and choose to proceed with her radiation therapy education as indicated herein.

The voluntary, written disclosure of pregnancy and her decision toward the UNC Hospitals Radiation Therapy Program will be kept in the student's folder, maintained by the program director. Release of such information may occur only upon the written permission of the student.

*Declaration*

I fully understand the contents of these documents, have had my questions answered to my satisfaction, and choose to proceed with my radiation therapy education as indicated below.

\_\_\_\_\_ I am fully aware of the UNC Hospitals Radiation Therapy Program pregnancy policy and choose to continue my didactic and clinical education without modification or interruption. If I am currently pregnant or become pregnant while in the radiation therapy program, I may notify my program director or clinical instructor voluntarily and in writing with one of the options below if I want to declare my pregnancy.

\_\_\_\_\_ **I am pregnant** and choose to continue my didactic and clinical education without modification or interruption. I accept full responsibility for my own actions and the health of my baby. Furthermore, I absolve, discharge, release, and hold harmless my clinical site and its staff, and the Board of Trustees of UNC Healthcare together with its officers and employees (the radiation therapy program and its faculty) for any legal liability, claims, damages, or complications that may occur during fetal growth, birth, and postnatal development of my baby.

\_\_\_\_\_ **I am pregnant** and choose to continue my didactic and clinical education with some modification of my clinical assignment. I will not participate in brachytherapy or CyberKnife procedures. A grade of incomplete will be given until I have completed all clinical education missed during my pregnancy. The completion of the incomplete may delay my sitting for the ARRT exam.

\_\_\_\_\_ **I am pregnant** and choose to take a leave of absence from clinical assignments during my pregnancy. A grade of incomplete will be given until I have completed all clinical education missed during my pregnancy. The completion of the incomplete may delay my sitting for the ARRT exam.

\_\_\_\_\_ **I am pregnant** and choose to take a leave of absence from the UNC Hospitals Radiation Therapy Program. If I notify the program director of my desire to return, I will be offered a position in the next class, the following year.

\_\_\_\_\_ I wish to withdraw my previous declaration of pregnancy.

I agree to comply with the above-stated policy with my decision as indicated above.

\_\_\_\_\_  
Student signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Program Director signature

\_\_\_\_\_  
Date

## Appendix B

### Prenatal Radiation Exposure, Regulatory Guide 8.13

#### A. Introduction

The Code of Federal Regulations in 10 CFR Part 19, “Notices, Instructions and Reports to Workers: Inspection and Investigations,” in Section 19.12, “Instructions to Workers,” requires instruction in “the health protection problems associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed.” The instructions must be “commensurate with potential radiological health protection problems present in the workplace.”

The Nuclear Regulatory Commission’s (NRC’s) regulations on radiation protection are specified in 10 CFR Part 20, “Standards for Protection Against Radiation”; and 10 CFR 20.1208, “Dose to an Embryo/Fetus,” requires licensees to “ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv).” Section 20.1208 also requires licensees to “make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman.” A declared pregnant woman is defined in 10 CFR 20.1003 as a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

This regulatory guide is intended to provide information to pregnant women, and other personnel, to help them make decisions regarding radiation exposure during pregnancy. This Regulatory Guide 8.13 supplements Regulatory Guide 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure” (Ref 1), which contains a broad discussion of the risks from exposure to ionizing radiation.

Other sections of the NRC’s regulations also specify requirements for monitoring external and internal occupational dose to a declared pregnant woman. In 10 CFR 20.1502, “Conditions Requiring Individual Monitoring of External and Internal Occupational Dose,” licensees are required to monitor the occupational dose to a declared pregnant woman, using an individual monitoring device, if it is likely that the declared pregnant woman will receive, from external sources, a deep dose equivalent in excess of 0.1 rem (1 mSv). According to Paragraph (e) of 10 CFR 20.2106, “Records of Individual Monitoring Results,” the licensee must maintain records of dose to an embryo/fetus if monitoring was required, and the records of dose to the embryo/fetus must be kept with the records of dose to the declared pregnant woman. The declaration of pregnancy must be kept on file, but may be maintained separately from the dose records. The licensee must retain the required form or record until the Commission terminates each pertinent license requiring the record.

The information collections in this regulatory guide are covered by the requirements of 10 CFR Parts 19 or 20, which were approved by the Office of Management and Budget, approval numbers 3150-0044 and 3150-0014, respectively. The NRC may not conduct or sponsor, and a

person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

## B. Discussion

As discussed in Regulatory Guide 8.29 (Ref. 1), exposure to any level of radiation is assumed to carry with it a certain amount of risk. In the absence of scientific certainty regarding the relationship between low dose exposure and health effects, and as a conservative assumption for radiation protection purposes, the scientific community generally assumes that any exposure to ionizing radiation may cause undesirable biological effects and that the likelihood of these effects increases as the dose increases. At the occupational dose limit for the whole body of 5 rem (50 mSv) per year, the risk is believed to be very low.

The magnitude of risk of childhood cancer following in utero exposure is uncertain in that both negative and positive studies have been reported. The data from these studies “are consistent with a lifetime cancer risk resulting from exposure during gestation which is two to three times that for the adult” (NCRP Report No. 116, Ref. 2). The NRC has reviewed the available scientific literature and has concluded that the 0.5 rem (5 mSv) limit specific in 10 CFR 20.1208 provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers associated with radiation exposure during pregnancy.

In order for a pregnant worker to take advantage of the lower exposure limit and dose monitoring provisions specified in 10 CFR Part 20, the woman must declare her pregnancy in writing to the licensee. A form letter for declaring pregnancy is provided in this guide or the licensee may use its own form letter for declaring pregnancy. A separate written declaration should be submitted for each pregnancy.

## C. Regulatory Position

### 1. Who Should Receive Instruction

Female workers who require training under 10 CFR 19.12 should be provided with the information contained in this guide. In addition to the information contained in Regulatory Guide 8.29 (Ref. 1), this information may be included as part of the training required under 10 CFR 19.12.

### 2. Providing Instruction

The occupational worker may be given a copy of this guide with its Appendix, an explanation of the contents of the guide, and an opportunity to ask questions and request additional information. The information in this guide and Appendix should also be provided to any worker or supervisor who may be affected by a declaration of pregnancy or who may have to take some action in response to such a declaration.

Classroom instruction may supplement the written information. If the licensee provides classroom instruction, the instructor should have some knowledge of the biological effects of radiation to be able to answer questions that may go beyond the information provided in this guide. Videotaped presentations may be used for classroom instruction. Regardless of whether the licensee provides classroom training, the licensee should give workers the opportunity to ask questions about information contained in this Regulatory Guide 8.13. The licensee may take credit for instruction that the worker has received within the past year at other licensed facilities or in other courses or training.

### 3. Licensee's Policy on Declared Pregnant Women

The instruction provided should describe the licensee's specific policy on declared pregnant women, including how those policies may affect a woman's work situation. In particular, the instruction should include a description of the licensee's policies, if any, that may affect the declared pregnant woman's work situation after she has filed a written declaration of pregnancy consistent with 10 CFR 20.1208.

The instruction should also identify who to contact for additional information as well as identify who should receive the written declaration of pregnancy. The recipient of the woman's declaration may be identified by name (e.g., John Smith), position (e.g., immediate supervisor, the radiation safety officer), or department (e.g., the personnel department).

### 4. Duration of Lower Dose Limits for the Embryo/Fetus

The lower dose limit for the embryo/fetus should remain in effect until the woman withdraws the declaration in writing or the woman is no longer pregnant. If a declaration of pregnancy is withdrawn, the dose limit for the embryo/fetus would apply only to the time for the estimated date of conception until the time the declaration is withdrawn. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

### 5. Substantial Variations Above a Uniform Monthly Dose Rate

According to 10 CFR 20.1208(b), "The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section," that is, 0.5 rem (5 mSv) to the embryo/fetus. The National Council on Radiation Protection and Measurements (NCRP) recommends a monthly equivalent dose limit of 0.05 rem (0.5 mSv) to the embryo/fetus once the pregnancy is known (Ref. 2). In view of the NCRP recommendation, any monthly dose of less than 0.1 rem (1 mSv) may be considered as not a substantial variation above a uniform monthly dose rate and as such will not require licensee justification. However, a monthly dose greater than 0.1 rem (1 mSv) should be justified by the licensee.

## D. Implementation

The purpose of this section is to provide information to licensees and applicants regarding the NRC's staff's plans for using this regulatory guide.

Unless a licensee or an applicant proposes an acceptable alternative method for complying with the specified portions of the NRC's regulations, the methods described in this guide will be used by the NRC staff in the evaluation of instructions to workers on the radiation exposure of pregnant women.

## Appendix C

### Questions and Answers Concerning Prenatal Radiation Exposure

#### 1. Why am I receiving this information?

The NRC's regulations (in 10 CFR 19.12, "Instructions to Workers") require that licensees instruct individuals working with licensed radioactive materials in radiation protection as appropriate for the situation. The instruction below describes information that occupational workers and their supervisors should know about the radiation exposure of the embryo/fetus of pregnant women.

The regulations allow a pregnant woman to decide whether she wants to formally declare her pregnancy to take advantage of lower dose limits for the embryo/fetus. This instruction provides information to help women make an informed decision to declare a pregnancy.

#### 2. If I become pregnant, am I required to declare my pregnancy?

No. The choice whether to declare your pregnancy is completely voluntary. If you choose to declare your pregnancy, you must do so in writing and a lower radiation dose limit will apply to your embryo/fetus. If you choose not to declare your pregnancy, you and your embryo/fetus will continue to be subject to the same radiation dose limits that apply to other occupational workers.

#### 3. If I declare my pregnancy in writing, what happens?

If you choose to declare your pregnancy in writing, the licensee must take measures to limit the dose to your embryo/fetus to 0.5 rem (5 mSv) during the entire pregnancy. This is one-tenth of the dose that an occupational worker may receive in a year. If you have already received a dose exceeding 0.5 rem (5 mSv) in the period between conception and the declaration of your pregnancy, an additional dose of 0.05 rem (0.5 mSv) is allowed during the remainder of the pregnancy. In addition, 10 CFR 20.1208, "Dose to an Embryo/Fetus," requires licensees to make efforts to avoid substantial variation above a uniform monthly dose rate so that all the 0.5 rem (5 mSv) allowed dose does not occur in a short period during the pregnancy.

This may mean that, if you declare your pregnancy, the licensee may not permit you to do some of your normal job functions if those functions would have allowed you to receive more than 0.5 rem, and you may not be able to have some emergency response responsibilities.

4. Why do the regulations have a lower dose limit for the embryo/fetus of a declared pregnant woman than for a pregnant worker who has not declared?

A lower dose limit for the embryo/fetus of a declared pregnant woman is based on a consideration of greater sensitivity to radiation of the embryo/fetus and the involuntary nature of the exposure. Several scientific advisory groups have recommended (Refs. 1 and 2) that the dose to the embryo/fetus be limited to a fraction of the occupational dose limit.

5. What are the potentially harmful effects of radiation exposure to my embryo/fetus?

The occurrence and severity of health effects caused by ionizing radiation are dependent upon the type and total dose of radiation received, as well as the time period over which the exposure was received. See Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Exposure" (Ref. 3), for more information. The main concern is embryo/fetal susceptibility to the harmful effects of radiation such as cancer.

6. Are there any risks of genetic defects?

Although radiation injury has been induced experimentally in rodents and insects, and in the experiments was transmitted and became manifest as hereditary disorders in their offspring, radiation has not been identified as a cause of such effect in humans. Therefore, the risk of genetic effects attributable to radiation exposure is speculative. For example, no genetic effects have been documented in any of the Japanese atomic bomb survivors, their children, or their grandchildren.

7. What if I decide that I do not want any radiation exposure at all during my pregnancy?

You may ask your employer for a job that does not involve any exposure at all to occupational radiation dose, but your employer is not obligated to provide you with a job involving no radiation exposure. Even if you receive no occupational exposure at all, your embryo/fetus will

receive some radiation dose (on average 75 mrem (0.75 mSv)) during your pregnancy from natural background radiation.

The NRC has reviewed the available scientific literature and concluded that the 0.5 rem (5 mSv) limit provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers. If this dose limit is exceeded, the total lifetime risk of cancer to the embryo/fetus may increase incrementally. However, the decision on what level of risk to accept is yours. More detailed information on potential risk to the embryo/fetus from radiation exposure can be found in Refs. 2-10.

8. What effect will formally declaring my pregnancy have on my job status?

Only the licensee can tell you what effect a written declaration of pregnancy will have on your job status. As part of your radiation safety training, the licensee should tell you the company's policies with respect to the job status of declared pregnant women. In addition, before you declare your pregnancy, you may want to talk to your supervisor or your radiation safety officer and ask what a declaration of pregnancy would mean specifically for you and your job status.

In many cases you can continue in your present job with no change and still meet the dose limit for the embryo/fetus. For example, most commercial power reactor workers (approximately 93%) receive, in 12 months, occupation radiation doses that are less than 0.5 rem (5 mSv) (Ref. 11). The licensee may also consider the likelihood of increased radiation exposures from accidents and abnormal events before making a decision to allow you to continue in your present job.

If your current work might cause the dose to your embryo/fetus to exceed 0.5 rem (5 mSv), the licensee has various options. It is possible that the licensee can and will make a reasonable accommodation that will allow you to continue performing your current job, for example, by having another qualified employee do a small part of the job that accounts for some of your radiation exposure.

9. What information must I provide in my written declaration of pregnancy?

You should provide, in writing, your name, a declaration that you are pregnant, the estimated date of conception (only the month and year need be given), and the date that you give the letter to the licensee. A form letter that you can use is included at the end of these questions and answers. You may use that letter, use a form letter the licensee has provided to you, or write your own letter.

10. To declare my pregnancy, do I have to have documented medical proof that I am pregnant?

NRC regulations do not require that you provide medical proof of your pregnancy. However, NRC regulations do not preclude the licensee from requesting medical documentation of your

pregnancy, especially if a change in your duties is necessary in order to comply with the 0.5 rem (5 mSv) dose limit.

11. Can I tell the licensee orally rather than in writing that I am pregnant?

No. The regulations require that the declaration must be in writing.

12. If I have not declared my pregnancy in writing, but the licensee suspects that I am pregnant, do the lower dose limits apply?

No. The lower dose limits for pregnant women apply only if you have declared your pregnancy in writing. The United States Supreme Court has ruled (in *United Automobile Workers International Union v. Johnson Controls, Inc.*, 1991) that “Decisions about the welfare of future children must be left to the parents who conceive, bear, support, and raise them rather than to the employers who hire those parents” (Ref. 7). The Supreme Court also ruled that your employer may not restrict you from a specific job “because of concerns about the next generation.” Thus, the lower limits apply only if you choose to declare your pregnancy in writing.

13. If I am planning to become pregnant but am not yet pregnant and I inform the licensee of that in writing, do the lower dose limits apply?

No. The requirement for lower limits applies only if you declare in writing that you are already pregnant.

14. What if I have a miscarriage or find out that I am not pregnant?

If you have declared your pregnancy in writing, you should promptly inform the licensee in writing that you are no longer pregnant. However, if you have not formally declared your pregnancy in writing, you need not inform the licensee of your nonpregnant status.

15. How long is the lower dose limit in effect?

The dose to the embryo/fetus must be limited until you withdraw your declaration in writing or you inform the licensee in writing that you are no longer pregnant. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

16. If I have declared my pregnancy in writing, can I revoke my declaration of pregnancy even if I am still pregnant?

Yes, you may. The choice is entirely yours. If you revoke your declaration of pregnancy, the lower dose limit for the embryo/fetus no longer applies.

17. What if I work under contract at a licensed facility?

The regulations state that you should formally declare your pregnancy to the licensee in writing. The licensee has the responsibility to limit the dose to the embryo/fetus.

## 18. Where can I get additional information?

The references to this Appendix contain helpful information, especially Ref. 3, NRC's Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure" for general information on radiation risks. The licensee should be able to give this document to you.

For information on legal aspects, see Ref. 7, "The Rock and the Hard Place: Employer Liability to Fertile or Pregnant Employees and Their Unborn Children – What Can the Employer Do?" which is an article in the journal *Radiation Protection Management*.

You may telephone the NRC Headquarters at (301) 415-7000. Legal questions should be directed to the Office of the General Counsel, and technical questions should be directed to the Division of Industrial and Medical Nuclear Safety.

You may also telephone the NRC Regional Offices at the following numbers: Region I, (610) 337-5000; Region II (404) 562-4400; Region III, (630) 829-9500; and Region IV, (817) 860-8100. Legal questions should be directed to the Regional Counsel, and technical questions should be directed to the Division of Nuclear Materials Safety.

### References for Appendix B & C Reports

1. National Council on Radiation Protection and Measurements, *Limitation of Exposure to Ionizing Radiation*, NCRP Report No. 116, Bethesda, MD, 1993.
2. International Commission on Radiological Protection, *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Ann. ICRP 21: No. 1-3, Pergamon Press, Oxford, UK, 1991.
3. USNRC, "Instruction Concerning Risks from Occupational Radiation Exposure," Regulatory Guide 8.29, Revision 1, February 1996.<sup>1</sup> (Electronically available at [www.nrc.gov/NRC/RG/index.html](http://www.nrc.gov/NRC/RG/index.html))
4. Committee on the Biological Effects of Ionizing Radiations, National Research Council, *Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V)*, National Academy Press, Washington, DC, 1990.
5. United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources and Effects of Ionizing Radiation*, United Nations, New York, 1993.
6. R. Doll and R. Wakeford, "Risk of Childhood Cancer from Fetal Irradiation," *The British Journal of Radiology*, 70, 130-139, 1997.
7. David Wiedis, Donald E. Jose, and Timm O. Phoebe, "The Rock and the Hard Place: Employer Liability to Fertile or Pregnant Employees and Their Unborn Children – What

Can the Employer Do? *Radiation Protection Management*, 11, 41-49, January/February 1994.

8. National Council on Radiation Protection and Measurements, *Considerations Regarding the Unintended Radiation Exposure of the Embryo, Fetus, or Nursing Child*, NCRP Commentary No. 9, Bethesda, MD, 1994.
9. National Council on Radiation Protection and Measurements, *Risk Estimates for Radiation Protection*, NCRP Report No. 115, Bethesda, MD, 1993.
10. National Radiological Protection Board, *Advise on Exposure to Ionizing Radiation During Pregnancy*, National Radiological Protection Board, Chilton, Didcot, UK, 1998.
11. M. L. Thomas and D. Hagemeyer, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities, 1996," Twenty-Ninth Annual Report, NUREG-0713, Vol. 18, US.

## **Safety Procedures**

Only you can make your experience a safe one. Most accidents are caused by unsafe acts of the person involved. Because of the nature of some of the activities at the hospital, it is of vital importance that each student become well-acquainted with the hazards involved in the operations of this department to protect him/herself, his/her coworkers, and his/her patients and to effectively safeguard hospital equipment and property.

It is important that you observe safe practices, keep your clinical area clean, and actively participate by suggesting improvements that will help make your clinical experience safe.

In the case of an accident, an incident report must be filled out and forwarded to the department Administrative Director immediately. Should the incident involve a patient, the patient is not to be sent away until seen by a physician. Appropriate care must be administered and the incident report should be signed by the involved patient. The program director is to be informed immediately, even if the incident appears to be of minor significance.

## **Incident Reports**

All incidents involving patients, visitors, students, or faculty/staff must be documented via a written incident report on forms provided.

### *Patient/Visitor Incident*

Where real or potential injury occurs, medical attention must be provided immediately. All involved persons must inform the clinical supervisor as soon as possible. In the event a student is involved the program director should be notified. A patient incident report form is to be filled out by the student and given to the clinical supervisor.

### *Student Incident*

In the event that a student is injured or suspectedly exposed to a communicable disease, the student is to notify the program director. The student is to obtain a release form from a physician before returning to the clinical area. A copy of this release form is to be maintained in the student's folder.

## **Health Status**

For the student to maintain his/her own health, it is necessary for him/her to have adequate health insurance coverage. The student is responsible for the expenses associated with illnesses and/or injuries. Clinical sites will provide emergency care, but are not responsible for the expenses associated with that care. Each student must provide proof of health insurance at the time of matriculation.

## **Student Maltreatment**

The UNC Hospitals Radiation Therapy Program has a zero tolerance policy for maltreatment of any student. Maltreatment is defined as any of the following behaviors:

1. Public humiliation
2. Threats of physical or psychological harm
3. Requirements to perform personal service for another individual
4. Limiting opportunities, grades, or any other activities because of gender, race, religion, or sexual orientation
5. Sexual advances, remarks, or innuendos
6. Offensive racial or religious remarks or actions

In order to be sure that these activities do not occur, the following will be observed:

1. The policy will be disseminated to all current and new students/employees.
2. There will be an annual discussion of maltreatment with employees at faculty/staff meetings.
3. Any individual who experiences or observes evidence of others not following this policy is obligated to report this to the program director, clinical supervisor, or Administrative Director. The program director will make an independent decision based on the situation as to whether the action is best reported to a higher level.

Additional policies (those that follow) are covered in program orientation. The student also receives a background check (JRCERT Standard 1), drug test, immunizations, an identification badge, and a personnel radiation monitor to protect his/her health and safety.

## Immunizations, Background Check and Drug screening

Additional policies (those that follow) are covered in program orientation. The student also receives a background check, drug test, immunizations, an identification badge, and a personnel radiation monitor to protect his/her health and safety. The background check and drug screen are administered by a company contracted with UNC Hospitals, and are paid for by the hospital. Information about the check will be communicated to students who are offered conditional acceptance to the program after interviews are completed annually. Students are required to have a currently BLS (Basic Life Support) certification upon the beginning of the program year, and it must be maintained as current while enrolled in the program.

The following immunizations are required by UNC Hospitals for admission to the program, and must be maintained as current (where applicable) through the program year:

Type:	Requirement:
☒ Measles	☒ 2 doses or positive titer
☒ Mumps	☒ 2 doses or positive titer
☒ Rubella	☒ 2 doses or positive titer
☒ Varicella	☒ 2 doses or positive titer
☒ Tetanus/Diphtheria/ (Tdap)	☒ 1 dose Tdap, then Td booster every 10 yr.
☒ Hepatitis B (HBV) Series	☒ Energix-B or Recombivax B 3 doses or positive titer If incomplete series, then ☒ Heplisav-B 2 doses 4 weeks apart  <i>For declination or waiver, a copy must be on file at the school and/or be approved by the facility or agency.</i>
☒ Influenza	☒ Annual- Fall See Academic/Agency guidelines  “Optimally, vaccination should occur before onset of influenza activity in the community. Health care providers should offer vaccination by the end of October” on the Influenza Vaccination Information for Health Care Workers’ page <a href="https://www.cdc.gov/flu/professionals/healthcareworkers.htm">https://www.cdc.gov/flu/professionals/healthcareworkers.htm</a>
☒ Tuberculosis Screening Preplacement  (https://www.cdc.gov/tb/topic/testing/healthcareworkers.htm) • Baseline Individual TB Risk Assessment including TB symptom evaluation, and either a 2-step TB skin test (given 1-3 weeks apart) or a	☒ Baseline Individual TB Risk Assessment ☒ Baseline TB Symptom Assessment ☒ 2-step TB skin test (given 1-3 weeks apart) OR  TB Blood Test within 12 months of program admission or readmission

TB blood test within 12 months of program admission or readmission. If a student has had a positive TB skin test in the past, such as due to TB exposure/infection or receiving the BCG vaccine, documentation of a chest x-ray for the + test will be required along with the Baseline Individual TB Risk Assessment and TB symptom evaluation.

☒ Documentation of a chest x-ray is required for a past + PPD or blood test. If current +PPD or blood test, additional evaluation for TB disease will be required as deemed necessary from a healthcare provider.  
☒ Annual TB education and risk assessment

The TB screening can be arranged to be done and paid for by UNC Hospitals' Employee Health during the first week of program orientation for incoming students.

### **Graduation Requirements/National ARRT Certification Examination**

Students who successfully complete the curriculum may be eligible to take the national certification examination offered by the ARRT. Successful completion of this program does not guarantee the student is eligible to take this examination, since the ARRT reviews the applications and determines eligibility for the examination.

Questions regarding eligibility should be directed to the ARRT ([arrt.org](http://arrt.org)). It is the responsibility of the student to apply for the certification examination. Applications usually take weeks to process.

Before a student enrolled in the UNC Hospitals Radiation Therapy Program can be eligible to apply for the radiation therapy examination or receive his/her certificate, he/she must fulfill the following requirements and obligations to UNC Hospitals (JRCERT Standard 1):

1. The student must have successfully met the academic requirements of the program as established by the grading system and academic standards of the program.
2. The student must have his/her fees and any fines accumulated paid in full before he/she can receive credit for his/her courses.
3. A student that has exceeded his/her allowable personal days (up to 40 hours), must make compensation for this extra time. This will involve clinical assignments after the scheduled date of completion. Refer to the aforementioned requirements in this document.
4. The student must have completed all projects and required work before he/she will be allowed to officially graduate.
5. The student must return all property (i.e., books, identification badges, etc.) or remit financial compensation for lost property.

The entering student will graduate 12 full months following the entrance date, provided he/she has met the full requirements.

### **Release of Student Records**

The student must sign a consent form to release his/her student records if he/she wants faculty/staff to provide verbal or written recommendations. Faculty may need to refer to student records to

make recommendations. All student records are released under the federal guidelines of the Family Educational Rights and Privacy Act (FERPA 1974). Student records are maintained in a locked file cabinet (JRCERT Standard 1.4). Students wishing to review any appropriate records should make an appointment with the program director. The student is encouraged to do such if he/she has any questions regarding his/her progress in the program.

## **UNC Hospitals Radiation Therapy Program Curriculum**

The UNC Hospitals Radiation Therapy Program curriculum is designed to integrate classroom and clinical education throughout the professional year. The student is limited to no more than 40 contact hours per week (JRCERT Standard 1). The courses below must be taken in sequence, beginning with the fall semester (JRCERT Standard 3.2). The formula for calculating credit hours is 37.5 contact hours = 3.0 credit hours (JRCERT Standard 3.5).

### **Courses**

#### **RTT 500 Foundations of Radiation Therapy**

A study of the responsibilities, ethics, and basic principles of radiation therapy with emphasis on the unique interpersonal relationships and special nursing care required of patients receiving radiation treatments.

#### **RTT 90 Medical Radiation Physics I**

A course in radiation physics that includes an emphasis on mathematics, radiation protection/safety, and quality assurance issues relating to medical application in radiation therapy medicine.

#### **RTT 595 Research Methodology and Design Statistics I**

The student is required to select an advisor and perform a clinical research project or conduct a literature review of a topic related to radiation therapy and/or cancer treatment.

#### **RTT 94 Radiation Dosimetry I**

A course emphasizing didactic and clinical application of dosimetric principles to radiation therapy treatment planning. Included are discussions of basic quality assurance measures, treatment simulations, manual and computer calculation methods, and basic dosimetry theories.

#### **RTT 531 Clinical Education in Radiation Therapy I**

A clinical course focusing on the applications of radiation via external and internal sources. With direct supervision, the student develops clinical skills through observation and participation in radiation therapy procedures. Laboratory sessions for simulation procedures are also included.

#### **RTT 596 Research Methodology and Design Statistics II**

The student is required to complete his/her research manuscript.

### RTT 550 Radiation Oncology

A study of the characteristics and treatment of benign and malignant tumors with emphasis on specific malignancies typically treated with radiation. Other information included covers symptoms, staging, modes of spread, and survival rates of various tumors.

### RTT 92 Medical Radiation Physics II

A continuation of RTT 90 with concentration on the relationship between radiation physics and radiation therapy.

### RTT 97 The Radiobiology of Radiotherapy

A course emphasizing didactic and clinical principles of radiobiology with relationship to radiation therapy. Included are discussions on cell structure, radiation dose, and basic radiobiology theory.

### RTT 532 Clinical Education in Radiation Therapy II

A clinical course focusing on the applications of radiation via external and internal sources. With direct supervision, the student develops clinical skills through observation and participation in radiation therapy procedures. Laboratory sessions for simulation procedures are also included.

### RTT 560 Radiation Safety

This course is an introduction to the sources of radiation. The content includes detection and measurement, source handling, survey methodology, maximum permissible doses, room design, and governmental regulations.

### RTT 600 Seminars in Radiation Oncology

A self-study review of all basic radiation therapy material included in the major areas of radiation therapy.

### RTT 533 Clinical Education in Radiation Therapy III

A continuation of RTT 532 with emphasis on procedures of great complexity and refinement of techniques for routine procedures.

*Total 43 hours*

The student is encouraged to seek academic counseling from the program director/instructor on any problem that might interfere with acceptable academic progress. Failure to seek such counseling from any resources available to the student, and to establish communication on that matter with the program director, will disqualify the circumstances as valid reasons for poor performance and/or expression of attitudes. For specific or more involved counseling needs, the program director will direct the student to the appropriate resources (JRCERT Standard 2.3).

Professional actions and attitudes, as set forth by the ARRT Code of Ethics, are as important as traditional academic standards in preparation to deliver a high standard of healthcare and service. A student may be judged unacceptable for continuation in the program, regardless of academic and/or clinical standing, when he/she has displayed a lack of professionalism with respect to patients, students, and faculty/staff. Although the following is not totally inclusive, the student's conduct at professional meetings/seminars is also considered. Although such activities may not be held on campus, the student is considered a representative of the program, hospital, university, and state while attending such functions and should conduct him/herself accordingly.

## Course Sequence

### Fall: Semester 1

RTT 90	Medical Radiation Physics I	3.0 hrs
RTT 94	Radiation Dosimetry I	3.0 hrs
RTT 500	Foundations of Radiation Therapy	3.0 hrs
RTT 531	Clinical Education in Radiation Therapy I	6.0 hrs
RTT 595	Research Methodology Design Statistics I	3.0 hrs
RTT 560	Radiation Safety	2.0 hrs

### Spring: Semester II

RTT 92	Medical Radiation Physics II	3.0 hrs
RTT 97	The Radiobiology of Radiotherapy	3.0 hrs
RTT 532	Clinical Education in Radiation Therapy II	6.0 hrs
RTT 550	Radiation Oncology	3.0 hrs
RTT 596	Research Methodology Design Statistics II	3.0 hrs

### Summer: Semester III

RTT 533	Clinical Education in Radiation Therapy III	3.0 hrs
RTT 600	Seminars in Radiation Oncology	<u>2.0 hrs</u>

**43 total hours**

## RTT 500 Foundations of Radiation Therapy

Fall 2021

Course Instructor

Matthew R Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

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Thursday (9:00 a.m. – 12:00 p.m.); 37.5 contact hours (3 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

A study of the responsibilities, ethics, and basic principles of radiation therapy with emphasis on the unique interpersonal relationships and special nursing care required of patients receiving radiation treatments.

Prerequisite: Admission to the UNC Hospitals Radiation Therapy Program

### Required Text and Handout Materials

Washington C, Leaver D. *Principles and Practice of Radiation Therapy*. 3<sup>rd</sup> edition.

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Test Performance	60%
Comprehensive Final Exam	20%
CT Tests	10%
Weekly Writing Assignments	5%
Review Questions, Questions to Ponder	5%

### Goals

1. To develop skills in basic patient care

2. To reinforce principles of radiation protection
3. To demonstrate effectiveness and efficiency while maintaining ethical standards
4. To demonstrate simulation and basic treatment planning assessment, implementation, design, and evaluation
5. To conceptualize the foundations of radiation therapy clinical practice

#### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

#### Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct. Your acceptance of enrollment presupposes a commitment to the principles embodied in the code of student conduct.

RTT 500

#### *Course Outline*

#### Section 1

1. Cancer: An Overview
  - a. Introduction
  - b. Historical overview
  - c. Overview
  - d. Current issues
  - e. Biological perspective
    - i. Tumor classification
  - f. Patient perspective
    - i. The person behind the diagnosis
    - ii. Cancer patient resources
  - g. Detection and diagnosis
    - i. Screening examinations
    - ii. Workup components
    - iii. Staging
    - iv. Grade

- h. Treatment options
  - i. Surgery
  - ii. Radiation therapy
  - iii. Chemotherapy
  - iv. Immunotherapy
- i. Prognosis
  - i. Patterns of spread
- j. Clinical trials
  - i. Retrospective studies
  - ii. Prospective studies
  - iii. Randomized studies
  - iv. Survival reporting
- k. Summary
- 2. Detection and Diagnosis
  - a. Introduction
  - b. The medical record and medical history
  - c. The physical examination
  - d. Screening
    - i. Sensitivity and specificity
    - ii. Sites
      - 1. Signs, symptoms, screenings, tests
  - e. Laboratory studies
  - f. Medical imaging
  - g. Cancer diagnosis
  - h. Staging systems
  - i. Summary

Readings: Chapter 1, Chapter 5

Do Review Questions, Questions to Ponder

## Section II

- 1. Historical overview of cancer management and education
  - a. Introduction
  - b. Early methods of cancer treatment
    - i. Ancient medicine
    - ii. Middle Ages
    - iii. Renaissance
  - c. Medical advances
    - i. Anesthesiology
    - ii. Asepsis

- iii. Advances in physics
- d. Contemporary cancer management
  - i. Surgical oncology
  - ii. Radiation oncology
  - iii. Medical oncology
  - iv. Biotherapy
- e. Evolution of cancer management and the radiation therapist
  - i. Governing agencies
  - ii. Educational background and the radiation therapist
  - iii. Educational advancement
  - iv. Patient rights and advocacy
- f. Radiation therapy social perspectives
  - i. Maslow's Hierarchy of Needs
  - ii. Clinical research
  - iii. Community education
- g. Summary

**Reading – Handouts (Chapter 9, and History of Rad Therapy document)**

Test: Sections I and II

Section III

1. The ethics and legal considerations of cancer management
  - a. Introduction
  - b. Ethical aspects of cancer management
    - i. Definitions and terminology
    - ii. Ethical theories and models
      1. Consequentialism
      2. Deontology
      3. Virtue ethics
      4. Engineering model
      5. Priestly model
      6. Collegial model
      7. Contractual model
      8. Covenant model
    - iii. Patient autonomy and informed consent
      1. Confidentiality
      2. Roles of other healthcare team members

- iv. Radiation therapist scope of practice
- v. Medical-legal aspects of cancer management
  - 1. Civil law
  - 2. Tort law
  - 3. Assault
  - 4. Battery
  - 5. False imprisonment
  - 6. Libel
  - 7. Slander
  - 8. Invasion of privacy
  - 9. Negligence
- vi. Legal doctrines
  - 1. Doctrine of personal liability
  - 2. Doctrine of respondeat superior
  - 3. Doctrine of res ipso loquitur
  - 4. Doctrine of foreseeability
- vii. Development of healthcare ethics
  - 1. Methods to analyze moral problems
  - 2. Issues
    - a. Autonomy, professional beneficence
  - 3. Societal risks and benefits
  - 4. Informed consent legal cases
    - a. Abortion
      - i. Roe vs. Wade
    - b. Confidentiality
      - i. Tarasoff vs. UCal Regents
- viii. Risk management
- ix. Medical records
- x. Summary

Reading: Chapter 2

Do Review Questions, Questions to Ponder

#### Section IV

- 1. Patient communication
  - a. Introduction
  - b. Levels and forms of communication
  - c. Communicating with cancer patients
  - d. The role of the radiation therapist in communicating within a healthcare setting
  - e. Summary

2. Patient assessment
  - a. Introduction
  - b. Establishing a therapeutic relationship
    - i. Minimal verbal response, reflecting, paraphrasing, probing, clarifying, interpreting, checking out, informing, confronting, summarizing
  - c. General health assessment
  - d. Physical assessment
    - i. Nutritional assessment
    - ii. Nutritional consequences of cancer
  - e. Pain assessment
    - i. Physiologic, sensory, affective, cognitive, behavioral, sociocultural
  - f. Blood assessment
  - g. Psychosocial assessment
    - i. Quality of life, coping strategies and responses – the patient, coping strategies and responses – the family
  - h. Cultural assessment
  - i. Spiritual assessment
  - j. Special cases in assessment
    - i. Children, adolescents, elderly

Reading: Chapter 3

Do Review Questions, Questions to Ponder

Test: Sections III and IV

### Section V

1. Operations for health services with application to radiation oncology
  - a. Introduction
  - b. Three types of medical information systems
    - i. Clinical systems
    - ii. Administrative systems
    - iii. Executive systems
    - iv. Value of electronic information
  - c. Historical perspective of healthcare information systems
    - i. 1950s, 60s, 70s, 80s, 90s, 00s, future
  - d. General systems theory
  - e. Planning and development
  - f. Hardware, software, databases, and database management systems
  - g. Analysis, design, acquisition, implementation, and evaluation
  - h. Radiation oncology clinical systems

- i. Radiation oncology administrative systems
- j. Information systems and strategic management
- k. Billing, budget, human resources, insurance

Reading: Handouts

Do Review Questions, Questions to Ponder

## Section VI

Cancer Biographies

## Section VII

1. Cancer etiology, epidemiology, and statistics
  - a. Introduction
  - b. Definitions and terminology
    - i. Sources of information
    - ii. Purposes of data collection
  - c. Cancer incidence
    - i. Age, gender, ethnicity, geography, risks
  - d. Cancer prevalence
  - e. Primary causes of cancer
    - i. Environmental factors
    - ii. Occupational factors
    - iii. Viruses
    - iv. Genetics
    - v. Iatrogenic
    - vi. Diet
    - vii. Tobacco
    - viii. Alcohol
    - ix. Chemicals
    - x. Stress
  - f. Uses of data collection
    - i. Prevention
    - ii. Detection
    - iii. Education
    - iv. Management
  - g. Examples of epidemiology in radiation oncology studies
  - h. Caveats of radiation oncology epidemiology studies
  - i. Statistics and cancer management
  - j. Summary

Readings: Epi\_lecture handout, Epidemiology\_Siemens handout

Test: Sections V, VI, and VII

### Section VIII

1. Planning for the future in the United States healthcare system
  - a. Introduction
  - b. Social factors impacting healthcare
  - c. Technological factors impacting healthcare
  - d. Economic factors impacting healthcare
  - e. Political factors impacting healthcare
  - f. Historical perspective of health policy in the United States
  - g. The dynamics of healthcare in the new century
    - i. The impact of healthcare costs
  - h. Summary

### Section IX

1. Thanatology
  - a. Introduction
  - b. Historical perspective of death and dying
    - i. Alternative images of an afterlife
    - ii. Four dimensions of death education
  - c. The contemporary American death system
    - i. Uncontrolled vs. controlled death
    - ii. Death and language
    - iii. Human-induced death
  - d. Coping with dying
    - i. Helping those who are coping with dying
    - ii. Physical, social, spiritual, and psychological tasks
    - iii. Hospice principles and caring for the dying
    - iv. Dying trajectories
  - e. Helping the dying
    - i. Dimensions of care
    - ii. Palliative care
    - iii. Hope
    - iv. Effective communication
  - f. Cultural differences and death
    - i. African Americans
    - ii. Hispanic Americans
    - iii. Asian Americans

- iv. Native Americans
- v. European Americans
- g. Life cycle perspectives
  - i. Children, adolescents, middle-aged, elderly
- h. Coping with belief systems
- i. Multiculturalism and healthcare
  - i. Legal aspects of multiculturalism
  - ii. Case studies implementing multiculturalism
- j. Summary

Reading: Handouts

### Section X

1. Stress and burnout in radiation oncology
  - a. Introduction
  - b. Theory of stress and burnout
  - c. Theoretical models of stress and burnout
  - d. Healthcare workers and stress and burnout
  - e. Studies of stress and burnout in healthcare and higher education
  - f. Commitment of radiation therapists and organizational culture

Reading: Akroyd/Adams article

Test: Sections VIII, IX, and X

### Section XI

1. Patient education

### Section XII

1. Principles of pathology
  - a. Introduction
  - b. Cells and the nature of disease
    - i. Inflammation
    - ii. Tissue damage
  - c. The pathology of neoplasms
    - i. Neoplastic diseases
  - d. Biology of the cancer cell
    - i. Tumor-suppressor genes

- ii. Oncogenes
- e. Summary

Reading: Chapter 3, pathology self study modules

Do Review Questions, Questions to Ponder

### Section XIII

1. Infection control in radiation oncology facilities
  - a. Introduction
  - b. Definitions
  - c. Infection cycle and disease phases
    - i. Incubation, clinical disease, convalescence
  - d. Transmission routes
  - e. Defense mechanisms
  - f. Evolution of isolation practices
    - i. Universal precautions
    - ii. Body substance isolation
    - iii. Standard precautions
  - g. Isolation fundamentals
  - h. Summary

Reading: Chapter 9-10

Do Review Questions, Questions to Ponder

### Section XIV

1. Pharmacology and drug administration
  - a. Introduction
  - b. Drug nomenclature
  - c. Pharmacologic principles
  - d. Variables affecting patient response
  - e. Professional drug assessment and management
    - i. Six rights of medication administration
    - ii. Implementing proper emergency procedures
  - f. Contrast media
  - g. Routes of drug administration
  - h. Legal aspects
  - i. Summary

Test: Sections XI, XII, XIV

Review

Comprehensive Final Exam

### **Weekly Writing Assignments - Fall**

Due by e-mail to the program director no later than 5:00 p.m. each Monday.

In 1 double-spaced page (Times New Roman, 12 pt, 1 inch margins), please respond to the following questions. You may write in the first person.

#### **Week 1**

As you complete orientation, of what are you most scared? To what are you most looking forward?

#### **Week 2**

As you start classes/clinical rotations, of what are you most scared?

#### **Week 3**

Get to know a radiation therapist. Where is he/she from? Where did he/she attend school (medical imaging, radiation therapy)? What does he/she do for fun? Why did he/she pursue a career in radiation therapy? How long has he/she been a radiation therapist? In his/her opinion, what is the most rewarding part of his/her job?

#### **Week 4**

In your opinion, what are the most important qualities for a radiation therapist to possess? Which will be the hardest for you to develop?

#### **Week 5**

Pick a patient (male or female). Describe his/her tumor(s) (location, stage, grade). Describe his/her set-up. Describe his/her treatment plan. Why is this plan the best for him/her?

#### **Week 6**

Describe your most interesting case this past week. The patient must be male.

#### **Week 7**

Describe your most interesting case this past week. The patient must be female.

#### **Week 8**

What is the most significant problem you have seen a radiation therapist overcome? What was the problem? How did he/she handle the situation? What was the outcome?

### **Week 9**

If has been a busy day in the clinic. The radiation therapist you are working with is tired and ready to go home. You see that he/she is about to make a mistake. What should you, as a student, do? Explain the importance of effective communication in this situation.

### **Week 10**

You are approached by a radiologic sciences student interested in applying to a radiation therapy educational program. Sell him/her the experience.

### **Week 11**

Make the most of your clinical rotation this week. Do something you have never done before. Describe this experience and how it made you feel. Will you include this in your daily/weekly/rotational routine? Why or why not?

### **Week 12**

Describe your most favorite and least favorite aspects of your current clinical rotation. Are there things you can do to make your experience a more positive one? Are there things others can do?

### **Week 13**

Looking back on this semester, of what are you most proud? What do you hope to accomplish next semester?

## **Weekly Writing Assignments – Spring**

### **Week 1**

As you begin your second semester, of what are you most scared? To what are you most looking forward?

### **Week 2**

You are a radiation therapy patient. Describe your experience from diagnosis to follow-up.

### **Week 3**

Pick a patient (male or female). Describe his/her tumor(s) (location, stage, grade). Describe his/her set-up. Describe his/her treatment plan. Why is this plan the best for him/her?

### **Week 4**

Describe your most interesting case this past week. The patient must be male.

### **Week 5**

Describe your most interesting case this past week. The patient must be female.

### **Week 6**

Describe your most difficult patient to date. Why was he/she and his/her set-up/plan so difficult? What did you do to make his/her treatment easier?

### **Week 7**

Describe one or more potential errors. Did you/would you report this/these errors? to whom? What did/could you do to prevent this/these errors?

### **Week 8**

Now that you are well into your second semester, how has your confidence changed? Are you comfortable in the clinical setting? What is something you feel you do well?

### **Week 9**

Describe your most embarrassing clinical experience. What did you learn?

### **Week 10**

When performing a competency, what makes you most nervous? What competency was hardest for you to complete?

### **Week 11**

How has your empathy for cancer patients changed? for patients' families?

## **Week 12**

Get to know a radiation therapist (not the one you interviewed last semester). Where is he/she from? Where did he/she attend school (medical imaging, radiation therapy)? What does he/she do for fun? Why did he/she pursue a career in radiation therapy? How long has he/she been a radiation therapist? In his/her opinion, what is the most rewarding part of his/her job?

## **Week 13**

Looking back on this semester, of what are you most proud? What do you hope to accomplish next semester?

### *CT Tests*

Friday (3:00 p.m. – 4:30 p.m.)

A review of the basic CT anatomy of the chest, abdomen, male pelvis, female pelvis, head, and neck, followed by an overview of the skeletal, genitourinary, aerodigestive, and nervous systems.

Madden, M. *Sectional Anatomy Review*.

### *Outline*

#### Section I

##### 1. Chest

#### *Chapter 1*

Test will cover all *except*: Figure 1-2 (1, 3), Figure 1-3 (3, 5), Figure 1-4 (1, 3, 5), Figure 1-5 (2, 4), Figure 1-6 (4), Figure 1-7 (4), Figure 1-8 (1), Figure 1-9 (2), Figure 1-10 (1, 3), Figure 1-11 (3, 4), Figure 1-12 (1, 2, 3), Figure 1-13 (1, 4), Figure 1-14 (1, 3, 4, 5), Figure 1-15 (2, 5), Figure 1-16 (1, 3, 4), Figure 1-17 (2, 4), Figure 1-21 (3), Figure 1-22 (2), Figure 1-25 (2), Figure 1-28 (4), Figure 1-29 (3, 4), Figure 1-30 (2), Figure 1-31 (5), Figure 1-33 (5)

#### Section II

##### 1. Abdomen

#### *Chapter 2*

Test will cover all *except*: Figure 2-3 (3), Figure 2-5 (1), Figure 2-5 (5), Figure 2-6 (5), Figure 2-12 (1), Figure 2-14 (2)

### Section III

#### 1. Male Pelvis

##### *Chapter 3 (Male Pelvis Only)*

Test will cover all *except*: Figure 3-5 (2), Figure 3-8 (4), Figure 3-15 (5), Figure 3-16 (2), Figure 3-19 (1, 3), Figure 3-20 (1, 4, 5), Figure 3-21 (1, 2, 3), Figure 3-25 (3), Figure 3-29 (3)

### Section IV

#### 1. Female Pelvis

##### *Chapter 3 (Female Pelvis Only)*

Test will cover all *except*: Figure 3-31 (5), Figure 3-33 (1), Figure 3-38 (1), Figure 3-39 (4, 5), Figure 3-40 (1), Figure 3-41 (5), Figure 3-42 (3), Figure 3-43 (5), Figure 3-44 (1), Figure 3-45 (1), Figure 3-49 (3), Figure 3-50 (2), Figure 3-52 (1), Figure 3-53 (3), Figure 3-54 (4)

### Section V

#### 1. Head

##### *Chapter 4*

Test will cover all *except*: Figure 4-1 (1, 4), Figure 4-2 (1, 2, 3, 5), Figure 4-3 (1, 2), Figure 4-4 (5), Figure 4-5 (1, 2, 4, 5), Figure 4-6 (2, 3, 4), Figure 4-7 (3, 4, 5), Figure 4-8 (2, 3, 4), Figure 4-9 (2, 3, 4), Figure 4-10 (2, 3, 4), Figure 4-11 (2, 3, 4, 5), Figure 4-12 (1, 3, 4, 5), Figure 4-13 (1, 2, 5), Figure 4-14 (2, 3), Figure 4-15 (3, 5), Figure 4-16 (1, 3), Figure 4-17 (3, 4), Figure 4-18 (2), Figure 4-19 (1, 2, 3), Figure 4-20 (2), Figure 4-21 (1, 2, 4), Figure 4-22 (1), Figure 4-23 (3, 4), Figure 4-24 (3), Figure 4-25 (1, 2, 4), Figure 4-26 (2, 5), Figure 4-27 (4), Figure 4-28 (1, 3), Figure 4-30 (1), Figure 4-31 (2, 4, 5), Figure 4-32 (1, 2), Figure 4-33 (2, 4), Figure 4-34 (1, 3, 4, 5), Figure 4-35 (1, 2, 3, 4, 5), Figure 4-36 (2, 3)

### Section VI

#### 1. Neck

##### *Chapter 5*

Test will cover all *except*: Figure 5-1 (3, 4, 5), Figure 5-2 (1, 5), Figure 5-3 (5), Figure 5-4 (1), Figure 5-5 (2, 3, 4), Figure 5-7 (3), Figure 5-8 (2, 5), Figure 5-10 (5), Figure 5-11 (4), Figure 5-12 (2, 3), Figure 5-13 (2), Figure 5-14 (2, 4), Figure 5-15 (3, 5), Figure 5-16 (3)

### Section VII

#### 1. Skeletal System

2. Genitourinary System

Section VIII

1. Aerodigestive System

2. Nervous System

## **RTT 595 Research Methodology and Design Statistics I**

Fall 2021

Course Instructor

Matthew R Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

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Thursday (1:00 p.m. – 4:00 p.m.); 37.5 contact hours (3 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

This course will provide the student with an overview of research methodology, descriptive and inferential statistics, and the beginnings of a written research project.

Prerequisite: Admission to the UNC Hospitals Radiation Therapy Program

### Required Text and Handout Materials

Handouts are designed to guide the student through this course.

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

A grading rubric is provided for the student.

### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

### Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct. Your acceptance of enrollment presupposes a commitment to the principles embodied in the code of student conduct.

## *Guidelines for Research Papers*

### Introduction: Requirement and Options

This document addresses the particular conditions under which the radiation therapy student is to meet the requirements of the knowledge, skills, and abilities associated with the research paper.

### Rationale

The purposes of the research paper are:

1. To gain an in-depth understanding of a radiation therapy-related issue or problem
2. To gain a critical appreciation for available relevant literature
3. To develop and implement the skills necessary to:
  - a. Formulate a researchable problem
  - b. Locate, summarize, and cite pertinent literature
  - c. Prepare a research protocol, including the selection of a methodology for the collection, analysis, and reporting of information
  - d. To determine, locate, and assess the appropriateness of data necessary and available to answer the question/solve the problem, and
  - e. Analyze, interpret, and present the data
4. To have the opportunity to integrate the knowledge and skills required through course materials, by applying didactic and clinical knowledge to a subject of particular interest to the student, and in a manner to prepare the student for similar professional tasks after graduation
5. To strengthen communication skills, and
6. To develop and enhance professional self-confidence

### Character of the Paper

The research paper is a serious piece of research, analysis, and writing, whose purpose is to foster an understanding and application of the scientific method as a basis for studying problems in radiation therapy. Moreover, it serves to demonstrate the student's ability to organize a study logically and systematically, as well as to present it in accurate and coherent writing.

Building on the student's work, the research paper begins with a question in the mind of the student (researcher), and continues with the following:

1. The expression of the question in the form of a problem, stated in clear, unambiguous terms, and buttressed by a review of the literature that is pertinent to the problem
2. A hypothesis, or educated conjecture, that will give direction to the student's thinking while examining the question
3. A plan, or design, for exploring the problem and its appropriate sub-problems
4. The collection of data/generation of information, and

5. An analysis of the data/information, organized into meaningful aggregates and appropriately interpreted

This paradigm of the research process has been further simplified into five questions that the paper is to explain and answer in the main sections indicated:

<i>What is the question/problem?</i>	Problem Statement
<i>What is/was known about it?</i>	Literature Review
<i>How will/did we find out more?</i>	Research Design
<i>What did we find?</i>	Data Presentation and Analysis
<i>What do the findings mean?</i>	Conclusions and Implications

These elements of the research paper are to be reflected in the student's paper.

### Types of Papers

Four types of papers are described in the following paragraphs.

#### *Hypothesis Testing*

This type of research involves the study of causal relationships: why things are as they are (or how they might be different than they are). Studies may be directed to the effects (or feasibilities or utilities) of programs, emerging technologies, or interventional strategies such as patient education. Almost invariably, this type of research requires the use of substantial amounts of quantitative data, which may be primary (collected by the student) or secondary (use of existing data). Any of a broad variety of research designs – experimental, quasi-experimental, and non-experimental – may be used.

#### *Bibliography-based Descriptive Studies*

This type of research is in the tradition of the scholarly treatise, drawing upon documentary material (published or unpublished). The contribution of this type of research to the field of radiation therapy is the development of fresh synthesis of ideas and information, which can serve to further understand issues and conditions, as well as provide a basis for the generation of hypotheses for further research. It is expected that, because the paper is mainly a literature review, the source information consulted and used will be extensive and exhaustive.

#### *Organizational Problem Analysis*

This type of research, usually cited in one or more specific organizations, is directed to the exploration/solution of a problem or method, resources, or intervention. As with other types, the problem orientation and the point of departure for solution as based on a search of the relevant

literature. A wide variety of research designs may be drawn upon, also including the case study. Almost invariably, these studies depend strongly on the collection of primary data/information to identifying the outcomes of the solution.

### *Data-based Descriptive Studies*

This type of research is aimed at describing a situation and finding out what the state of affairs is, with or without some explanatory elements. Its utility is mainly in gaining knowledge and understanding of problems, needs, and constraints (attitudinal and objective). It may be directed toward problematic aspects of radiation therapy practice and the environment. Conduct of such studies usually involves the collection of survey data, with analysis at varying levels of statistical sophistication. Like the preceding types, these studies require extensive review of the literature to gain insights into the structure of problems, so as to identify the variables on which data are to be collected.

### Advisement

All papers are developed under the advisement of a qualified member of the UNC Department of Radiation Oncology faculty/staff.

The paper must be judged acceptable to fulfill the program's requirements by both the faculty advisor and the second reader.

### Selecting the Paper Topic

Each student, in consultation with and with the approval of the faculty/staff advisor, decides upon the topic of the paper to be completed. The student should select a topic in which his or her interest is sufficient to maintain a high level of motivation and satisfaction throughout the research endeavor. Conducting the research and preparing the paper often requires more work and takes more time than the student anticipates, and so the topic should be one of personal or professional importance.

### Specifications of the Paper

The paper should, in general, include the elements below. However, in papers of the bibliography-based descriptive studies type, some elements may require substitutions.

Title page

Abstract

Table of contents

Introduction, including a statement of the problem studied and the significance of the topic for radiation therapy

Literature review, including substantive summaries of the major subjects and a statement that defines the point from which the original investigation begins

Research design and methodology

Presentation of all data/information

Analysis and interpretation of data and statement of findings

Conclusions regarding the significance of the findings for the problem, for further studies, and for the field of radiation therapy

References/bibliography

Appropriate appendices

#### Format

Approximate length of the paper will range from 8-20 pages. Appropriate length of the paper is judged by the nature of the topic and the need to give adequate attention to all specified elements of the paper rather than to any pre-established standard.

All papers should be prepared with the standards of journal publication in mind. If judged appropriate by the faculty/staff advisor, the paper may be submitted in the form of an article-length manuscript.

The form and style of the paper may follow that of the American Medical Association.

The paper should be typed on 8 ½" x 11" white paper, double spaced.

#### Expenses

All expenses related to the research paper are the responsibility of the student.

#### Publications Resulting from the Papers

In many cases the faculty/staff advisor and the second reader – and perhaps others – may play a significant role in guiding the student through the development of the paper.

Publications resulting from the paper may, therefore, raise questions with regard to publication credit. Responsibilities in the Paper Process

The student is responsible for the following:

1. Selecting the type and topic of the paper with the concurrence of the advisor, and
2. Conducting the research and writing the paper.

## RTT 94 Radiation Dosimetry I

Fall 2021

Course Instructor

Matthew R Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

Phone: (984) 974-8629

E-mail: Matthew.Hawkins@unchealth.unc.edu

Tuesday (1:00 p.m. – 4:00 p.m.); 37.5 contact hours (3 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

A course emphasizing didactic and clinical application of dosimetric principles to radiation therapy treatment planning. Included are discussions of basic quality assurance measures, treatment simulations, manual and computer calculation methods, and basic dosimetry theories.

Prerequisite: Admission to the UNC Hospitals Radiation therapy Program

### Required Text and Handout Materials

Stanton, Stinson. *Applied Physics for Radiation Oncology*.

Reference: Khan F. *The Physics of Radiation Therapy*.

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Test performance                      75%

Comprehensive final exam      25%

### Goals

1. To develop basic dosimetry terminology and mathematical concepts
2. To introduce the student to radiation therapy and dosimetry equipment
3. To examine radiation dosimetry physics
4. To introduce means of measuring radiation dose and quality assurance
5. To provide a systematic approach to radiation therapy treatment planning and dose calculation

6. To explain the rationale and procedures for various treatment verification procedures
7. To teach the student the rationale and procedures for complex dose calculations and treatment set-ups
8. To introduce the student to electron beam therapy and treatment planning rationale and procedures
9. To introduce the student to the various aspects of brachytherapy, including physics, quality assurance, safety procedures, treatment planning, and dose calculations
10. To teach the basic concepts behind computer technology and computer applications in radiation therapy

### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

### Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct. Your acceptance of enrollment presupposes a commitment to the principles embodied in the code of student conduct.

RTT 94

### *Course Outline*

#### Section I

##### *Objectives:*

1. To understand the conceptual use of language, mathematical concepts, quality assurance, and quality control in medical dosimetry
2. To comprehend dosimetric ratios, conversion factors, dose and monitor units, concepts of similar triangles, gap calculations, inverse proportions, and interpolations
3. To comprehend concepts of localization, geometric factors, and special techniques: GTV, CTV, PTV
4. To understand the concept of electronic portal imaging devices and magnification
5. To comprehend propagation of randomization and systematic dose errors in radiation therapy treatment planning
6. To understand the concepts of equipment operation, monitoring, and record keeping
7. To comprehend immobilization techniques used in radiation therapy

Readings: Chapters 7, 13, 14

Reference: Chapters 8, 16, 17 (Khan)

DOSE computer-based learning modules

Tumor Volumes

DVH Evaluation

## Section II

*Objectives:*

1. To comprehend the concept of tissue equivalence
2. To describe percent depth dose (PDD)
3. To discuss the concepts of build-up region and skin sparing
4. To understand how field size, distance, and quality dependence affect dose
5. To understand and use the formula for the Mayneord correction factor

Readings: Chapters 24, 25

Reference: Chapter 9 (Khan)

DOSE computer-based learning modules

Spine

## Section III

*Objectives:*

1. To understand the concepts of tissue air ratio (TAR), backscatter factor (BSF), field size, depth, and quality dependence
2. To discuss the TAR/PDD relationship and conversion formula
3. To discuss the use of TAR in rotational therapy
4. To comprehend dose calculations for PDD, TAR, and TMR and the relationship among the three concepts

Readings: Chapters 24, 25

DOSE computer-based learning modules

Whole Brain

## Section IV

*Objectives:*

1. To conceptualize hand planning and computer planning calculations for isodose lines for the following set-ups: single field, parallel opposed, three field, wedge pair, and four field
2. To describe how penumbra affects isodose distribution
3. To describe how beam quality affects isodose distribution
4. To understand how attenuators affect isodose distribution
5. To comprehend how the flattening filter affects isodose distribution
6. To understand the concept of normalization

Reading: Chapter 25

Reference: Chapter 11 (Khan)

DOSE computer-based learning modules

2-fld vs. 4-fld

Wedges

Section V

*Objectives:*

1. To understand how to calculate a hand-drawn contour
2. To describe the importance of proper positioning
3. To discuss how CT, MRI, and PET are used in treatment planning
4. To comprehend important concepts related to patient simulation
5. To discuss the importance of SARs and Clarkson calculations
6. To perform calculations utilizing the concepts of SARs and Clarkson calculations
7. To calculate areas for blocked and unblocked equivalent squares
8. To describe the concept of blocking in radiation therapy
9. To understand how to work problems for determining the half value layers of megavoltage beams
10. To comprehend the concepts of both independent collimation and multileaf collimation
11. To describe electron contamination and skin dose
12. To describe how field abutment is critical in radiation therapy utilizing similar triangles
13. To describe how matching different fields may utilize trigonometric calculations

Readings: Chapters 6, 8, 21, 22, 23

Reference: Chapters 12, 13, (Khan)

DOSE computer-based learning modules

## Photons

### Section VI

#### *Objectives:*

1. To discuss the concepts of electron production, electron collision, practical electron range, and average electron energy
2. To understand the methodology used to produce electron isodose curves
3. To comprehend the use of electron calculations
4. To discuss random equivalence, exposure rate constant, and seven radioisotopes
5. To understand the concept of inverse square law
6. To discuss linear source and point source
7. To describe different implant systems
8. To discuss interstitial implants, intracavitary implants, and remote afterloading
9. To understand the concept behind brachytherapy calculations

Readings: Chapters 15, 26

Reference: Chapters 14, 15 (Khan)

RTT 94

#### *Course Overview*

Dosimetry language and concepts
Immobilization, modality, and energy selection
TEST 1
Tissue equivalence, PDD, build-up region, skin sparing, field size, distance, beam quality
Mayneord correction factor, TAR, BSF, SAR, irregular fields, equivalent squares, inverse square law, quality dependence
TEST 2
SSD calculations from PDD
SAD calculations from TAR
SAD calculations from TMR, rotational therapy
Co60, superficial, orthovoltage
TEST 3
Isodose lines, single field
Inhomogeneous single field, parallel opposed field
Three field, wedge pair

Four field
TEST 4
Clarkson calculations
Blocking, half value layers, multileaf collimators, electron contamination, field abutment, matching, CNS
TEST 5
Electrons, electron composites
Brachytherapy
Inverse treatment planning, IMRT, image segmentation
TEST 6
Review
EXAM

## **RTT 531 Clinical Education in Radiation Therapy I**

Fall 2021

Course Instructor

UNC registered radiation therapists

Monday, Wednesday, Friday (8:00 a.m. – 4:30 p.m.); 360 contact hours (6 credit hours)

Location: UNC Radiation Oncology

### Course Description

This is the first of a three course sequence. During this course, the student focuses on the application of radiation via external radiation beams. While in the clinical setting, the student observes and works directly with a registered radiation therapist. Emphasis is given on learning and understanding the role and responsibility of a radiation therapist in the clinical setting. In addition, CT simulation laboratory sessions are taught by Ms. Traci Leach, BS, RT(R)(T).

Prerequisite: Admission to the UNC Hospitals Radiation Therapy Program

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Clinical competencies	50%
<1 with a grade of 80 or above	0 points
1 with a grade of 80 or above	20 points
2 with a grade of 80 or above	25 points
3 with a grade of 80 or above	30 points
4-5 with a grade of 80 or above	35 points
6-7 with a grade of 80 or above	40 points
8-9 with a grade of 80 or above	45 points
10 or > with a grade of 80 or above	50 points
Professional Profile	30%
Overall Semester Evaluation	10%

Clinical Evaluation	10%
Clinical Activities	20%
Clinical Reviews	10%
Simulation Lab Sessions	10%

### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

### Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct. Your acceptance of enrollment presupposes a commitment to the principles embodied in the code of student conduct.

RTT 531

### *Course Objectives*

1. To introduce the student to the basic clinical operations of a radiation therapy department
2. To perform basic CT simulation and linear accelerator procedures
3. To introduce the student to various quality assurance procedures of both the CT simulator and linear accelerators
4. To introduce the student to the performance of various clinical procedures
5. To allow the student to perform under direct supervision less complex set-ups
6. To demonstrate an understanding of the basic clinical concepts of radiation therapy practice
7. To demonstrate an understanding of theory and principles of operation of linear accelerators and CT simulators
8. To demonstrate an understanding of the different types of radiation protection
9. To develop patient care, communication, and critical thinking skills with patients, healthcare providers, and patient support personnel
10. To monitor professional behaviors and alter clinical practice with regard to feedback from performance evaluations
11. To develop greater accountability and responsibility for patient safety

### *Course Requirements*

**Clinical Practice:** The student is expected to attend clinical on time for the assigned rotation, wearing proper clinical attire. Proper clinical attire includes a white lab coat, an identification badge, and a radiation monitor.

**Attendance:** Any time the student is absent, late, or has a change in his/her schedule, he/she must notify the program director and his/her clinical instructor(s). All absences must either count as a vacation day/personal day or, if possible, be made up.

**Clinical Procedures:** The student is expected to participate in clinical procedures under direct supervision. The student's participation in clinical procedures directly affects his/her clinical evaluations.

**Competency Evaluations:** The student is required to demonstrate competency performing clinical simulations and treatments. Competency involves successful completion of the Competency Evaluation form. 10 competencies must be completed by the end of the first semester. The student will not be allowed to begin RTT 532 until this requirement is met.

The student is expected to achieve at least one successful Competency Evaluation form on each simulation/treatment listed on the Clinical Competency Requirements list prior to his/her graduation. The Clinical Competency Requirements list, however, is only the minimum number of competencies the student is expected to complete while in the program.

**Clinical Documentation:** Clinical documentation must be complete and turned in weekly to the program director. Completeness includes neatness and accuracy and requires clinical staff signatures. Failure to turn in complete documentation will result in a deduction in the documentation section of the student's final clinical grade.

### *Instructions for Clinical Paperwork*

The student is required to turn in clinical paperwork each week/after each rotation to the program director.

Clinical paperwork includes the following in the proper order (top to bottom), fastened with a paper clip:

Self Evaluation (student)

Evaluation of Clinical Environment (student)

Weekly Clinical Evaluation (clinical instructor)

Overall Clinical Evaluation (clinical instructor)

CT Competency Evaluation/Treatment Competency Evaluation (if any, clinical instructor)

*Instructions for Performing Competency Evaluations*

Both the student and the clinical instructor decide when the student is ready to perform a particular simulation/treatment independently with direct supervision.

The student informs the clinical instructor that he/she wishes to perform a competency on an upcoming simulation/treatment. He/she gives his/her clinical instructor the Competency Evaluation form.

The student performs all aspects of the competency independently under direct supervision.

If the student receives a score of 80 or above in all performance categories, he/she will have successfully completed the competency.

RTT 531

*Glossary of Terms*

**Clinical Reviews:** During the student's clinical rotations, the program director will review the student's progress with him/her individually. He/she is evaluated on how well he/she has integrated course materials from class, lab, and clinical. Scores from the student's reviews will be averaged to determine his/her Clinical Reviews grade.

**Completion and Quality of Documents:** Proper completion and acceptable quality includes accuracy, completeness, neatness, and meeting deadlines. Documentation is an important part of the student's clinical education and can significantly affect his/her semester grade.

**Evaluation of Clinical Environment –** The student should complete one or more of these forms at the end of each rotation, considering the overall educational experience he/she has been provided.

**Overall Semester Evaluation –** This is completed by the program director with input from the clinical instructors at the end of the semester. The program director will evaluate the student's overall performance progression throughout the semester based on four criteria: clinical adaptability, professional appearance, efficient use of educational opportunities, and clinical performance.

Self Evaluation: The student should complete this form on the last day of each week of his/her rotation. This form, in combination with the Weekly Clinical Evaluation form, will help the student, the program director, and the clinical instructors monitor the student's clinical skills development.

Time Sheet – Clinical time must be recorded on a time sheet with clinical instructors' initials.

Weekly Clinical Evaluation: This evaluation is completed by the student's clinical instructor at the end of each week. The clinical instructor will complete the form and return it to the student.

## CLINICAL TIME SHEET

NAME: \_\_\_\_\_ CLINICAL ROTATION: \_\_\_\_\_

\*Time sheet is to be kept current at all times and turned in at the end of the rotation.

\*Indicate: Number of hours present when present; Number of hours absent when absent. H = Holiday; P = Personal Day; I = Interview Day

\*Five personal days are specified during the program year. If you are absent for any additional time, the time must be made up.

\*Failure to comply with the hours assigned by your clinical site will affect your clinical grade.

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hours Made Up (+ Date)	Preceptor Initials		
July																																			
August																																			
September																																			
October																																			
November																																			
December																																			
January																																			

STUDENT SIGNATURE: \_\_\_\_\_ DATE: \_\_\_\_\_

**Self Evaluation:** Considering your level of experience, evaluate yourself according to the following criteria. Comments and suggestions are very important components of evaluation feedback, so please include when possible.

	Weak		Strong		
	1	2	3	4	5
<b>PATIENT CARE SKILLS</b>					
patient safety, patient comfort, awareness of patient condition, patient emotional support, patient radiation protection					
COMMENTS:					

	1	2	3	4	5
<b>LINAC/SIMULATOR SKILLS</b>					
psychomotor skills, use of room controls, use of console controls					
COMMENTS:					

	1	2	3	4	5
<b>CHART SKILLS</b>					
chart interpretation, writing in chart for simulation, writing in chart for treatment					
COMMENTS:					

	1	2	3	4	5
<b>ORGANIZATIONAL SKILLS</b>					
cleaning and stocking rooms, preparation for patients, prioritizing procedures/ patients, following through with all aspects of procedures					
COMMENTS:					

	1	2	3	4	5
<b>TEAMWORK SKILLS</b>					
communication skills, motivation, dependability, assists staff and other students					
COMMENTS:					

**Student Signature/Date:** \_\_\_\_\_

## Weekly Evaluation

Student Name:

Date:

Consider each item separately and rate each item independently of all others. Circle the rating that indicates the extent to which you agree with each statement. Please do not skip any rating. If you do not know about a particular area, please circle N/A.

5 = strongly agree 4 = generally agree 3 = neutral (acceptable) 2 = generally disagree  
1 = strongly disagree N/A = not applicable

### I. Knowledge Base (Cognitive Domain)

The student...

1. has the oncology care knowledge necessary to function in a healthcare setting	5	4	3	2	1	N/A
2. has the general medical knowledge base necessary to function in a healthcare setting	5	4	3	2	1	N/A
3. collects data from charts and patients	5	4	3	2	1	N/A
4. implements patient data	5	4	3	2	1	N/A
5. evaluates treatment techniques in order to perform appropriate procedures	5	4	3	2	1	N/A
6. uses sound judgment while functioning in a healthcare setting	5	4	3	2	1	N/A

Comments:

### II. Clinical Proficiency (Psychomotor Domain)

The student...

1. performs a broad range of radiation therapy examinations	5	4	3	2	1	N/A
2. has skills to critique treatment plans	5	4	3	2	1	N/A
3. integrates anatomy, treatment planning, and radiation therapy	5	4	3	2	1	N/A
4. uses software to analyze, evaluate, and Implement data	5	4	3	2	1	N/A

Comments:

### III. Behavioral Skills (Affective Domain)

The student...

1. communicates effectively within a healthcare setting	5	4	3	2	1	N/A
2. conducts his/herself in an ethical and professional manner	5	4	3	2	1	N/A
3. manages time efficiently while functioning in a healthcare setting	5	4	3	2	1	N/A

Comments:

**Clinical Instructor's Signature/Date:** \_\_\_\_\_

**Evaluation of Clinical Environment:** Rotation (Simulator/Name of Linac):

Dates:

Clinical Instructor (First AND Last Name):

Please evaluate your clinical environment considering the following criteria:

**CLINICAL STAFF**

	<u>Never</u>	<u>Rarely</u>	<u>Sometimes</u>	<u>Often</u>	<u>Always</u>
Maintains a friendly, professional attitude towards students	1	2	3	4	5
Maintains a professional attitude towards his/her career, speaks positively about students entering the profession	1	2	3	4	5
Demonstrates and explains equipment	1	2	3	4	5
Demonstrates and explains exams/treatments	1	2	3	4	5
Encourages students to ask questions	1	2	3	4	5
Encourages students to attempt exams/treatments with supervision	1	2	3	4	5
Points out items of importance, assists in correcting errors	1	2	3	4	5
Encourages an environment conducive to learning, is patient, considerate, and helpful	1	2	3	4	5

**CLINICAL ENVIRONMENT**

Was this your first rotation in this clinical area?	Yes	OR	No		
	<u>Never</u>	<u>Rarely</u>	<u>Sometimes</u>	<u>Often</u>	<u>Always</u>
The clinical area had a steady patient flow.	1	2	3	4	5
I was exposed to a variety of procedures.	1	2	3	4	5
My assigned area was consistently staffed with clinical personnel.	1	2	3	4	5
My assigned area was consistently staffed with support personnel (transporters, nurses).	1	2	3	4	5
My clinical environment was conducive to learning (organized, efficient, resourceful).	1	2	3	4	5

**Overall Evaluation**

Student Name:

Criteria:

	<b>High</b>				<b>Low</b>
<b>Clinical Adaptability</b>	5	4	3	2	1
<b>Professional Appearance</b>	5	4	3	2	1
<b>Efficient Use of Educational Opportunities</b>	5	4	3	2	1
<b>Clinical Performance</b>	5	4	3	2	1

\_\_\_\_\_  
Clinical Instructor's Signature:

\_\_\_\_\_  
Date:

**Additional Comments:**

## Treatment Competency Evaluation

Student:	Grading Explanation: 5 Student can explain, do, and comprehend task 4 Student can explain, do task, and answer questions 3 Student can do task with no explanations 2 Student can partially do task 1 Student cannot do task
Date:	
Procedure:	
Circle One: Simulation OR Clinical	

		5	4	3	2	1
1	Prepares treatment room					
2	Reviews chart prior to prepping patient for treatment					
3	Greets and assists correct patient to treatment room and meets patient's needs (hearing, wheelchair, etc.)					
4	Explains procedure and confirms understanding					
5	Answers all patient questions					
6	Attends to patient modesty and comfort					
7	States patient's diagnosis & stage					
8	Reproduces set-up from chart					
9	Further immobilizes patient if necessary					
10	Positions treatment machine to reproduce set-up in chart					
11	Assures light fields align with marks/tattoos					
12	Inserts correct wedge(s)/compensator(s)					
13	Positions bolus material					
14	Maintains patient markings					
15	Rechecks with set-up in chart					
16	Obtains port films when needed					
17	Instructs patient to remain still during treatment					
18	Downloads/treats correct field(s)					
19	Operates console computer					
20	Monitors patient visually					
21	Monitors linac recordings					
22	Records treatment/charges patient appropriately					
23	Refers patient to appropriate medical personnel					
24	Completes procedure in a reasonable time period					

Clinical Instructor's Signature/Date: \_\_\_\_\_

Student's Signature/Date: \_\_\_\_\_

**Student's Overall Comprehension Level of Patient Set-Up and Chart Write-Up**

\_\_\_ The student demonstrates **comprehensive knowledge** of basic and advanced concepts beyond requirements of the procedure (12.5)

\_\_\_ The student demonstrates **above average understanding** of basic concepts applicable to the procedure (10)

\_\_\_ The student demonstrates **adequate knowledge** of the essential elements of the procedure (8)

\_\_\_ The student shows **limited understanding** of the essential concepts related to the procedure (4)

\_\_\_ The student has **inadequate** knowledge of even the basic concepts related to the procedure (0)

### **Student's Behavioral Characteristics**

\_\_\_ In performing the patient set-up, the student proceeded **confidently and skillfully without** any hesitation, assistance from the clinical instructor, or asking any questions (12.5)

\_\_\_ In performing the patient set-up, the student proceeded **confidently and skillfully with** (check all that apply): 1(11), 2(10), 3(9)

\_\_\_ one or two minor hesitations or seeming uncertainty(ies)

\_\_\_ one or two instances requiring minor assistance from the clinical instructor

\_\_\_ one or two minor questions being asked

\_\_\_ other \_\_\_\_\_

\_\_\_ In performing the patient set-up, the student was **confident and skillful with** (check all that apply): 1(8), 2(7), 3(6)

\_\_\_ more than one or two minor OR one major hesitation(s) or uncertainty(ies)

\_\_\_ more than one or two minor OR one major instance(s) requiring assistance from the clinical instructor

\_\_\_ more than one or two minor OR one major question(s) being asked

\_\_\_ other \_\_\_\_\_

\_\_\_ In performing the patient set-up, the student was **lacking in confidence and/or skill** with (check all that apply): 1(5), 2(4), 3(3)

\_\_\_ more than one or two minor OR one major hesitation(s) or uncertainty(ies)

\_\_\_ more than one or two minor OR one major instance(s) requiring assistance from the clinical instructor

\_\_\_ more than one or two minor OR one major question(s) being asked

\_\_\_ other \_\_\_\_\_

\_\_\_ In performing the patient set-up, the student exhibited carelessness, lack of attention to detail, little self-confidence, and **should repeat the procedure** (0)

## CT Simulation Competency Evaluation

Student:	Grading Explanation: 5 Student can explain, do, and comprehend task 4 Student can explain, do task, and answer questions 3 Student can do task with no explanations 2 Student can partially do task 1 Student cannot do task
Date:	
Procedure:	
Circle One: Simulation OR Clinical	

		5	4	3	2	1
1	Checks for consent					
2	Checks Quick RX orders					
3	Prepares room					
4	Registers patient in CT					
5	Greets and assists correct patient to room and verifies name and DOB					
6	Explains procedure and confirms understanding					
7	Takes and downloads photos					
8	Answers all patient questions					
9	States patient diagnosis & stage					
10	Attends to patient modesty and comfort					
11	Positions patient in reproducible/safe manner					
12	Texts/pages radiation oncologist to CT/Sim					
13	Uses correct contrast media or catheters to localize/identify structures					
14	Instructs patient to hold still					
15	Sets program ranges for topogram					
16	Assists radiation oncologists with all activities					
17	Transfers images and sets table height					
18	Navigates through tumor loc including marking iso					
19	Sends iso(s) to lasers and tattoos patient/marks on mask					
20	Fills out patient set-up sheet and enters information into MOSAIQ					
21	Schedules patient					
22	Explains appointments and performs clinic tour					
23	Completes QCL					
24	Charges patient appropriately					
25	Completes exam in timely manner					

Clinical Instructor's Signature/Date: \_\_\_\_\_

Student's Signature/Date: \_\_\_\_\_

**Student’s Overall Comprehension Level of Patient Set-Up and Chart Write-Up**

\_\_\_ The student demonstrates **comprehensive knowledge** of basic and advanced concepts beyond requirements of the procedure (12.5)

\_\_\_ The student demonstrates **above average understanding** of basic concepts applicable to the procedure (10)

\_\_\_ The student demonstrates **adequate knowledge** of the essential elements of the procedure (8)

\_\_\_ The student shows **limited understanding** of the essential concepts related to the procedure (4)

\_\_\_ The student has **inadequate** knowledge of even the basic concepts related to the procedure (0)

**Student’s Behavioral Characteristics**

\_\_\_ In performing the patient set-up, the student proceeded **confidently and skillfully without** any hesitation, assistance from the clinical instructor, or asking any questions (12.5)

\_\_\_ In performing the patient set-up, the student proceeded **confidently and skillfully with** (check all that apply): 1(11), 2(10), 3(9)

\_\_\_ one or two minor hesitations or seeming uncertainty(ies)

\_\_\_ one or two instances requiring minor assistance from the clinical instructor

\_\_\_ one or two minor questions being asked

\_\_\_ other \_\_\_\_\_

\_\_\_ In performing the patient set-up, the student was **confident and skillful with** (check all that apply): 1(8), 2(7), 3(6)

\_\_\_ more than one or two minor OR one major hesitation(s) or uncertainty(ies)

\_\_\_ more than one or two minor OR one major instance(s) requiring assistance from the clinical instructor

\_\_\_ more than one or two minor OR one major question(s) being asked

\_\_\_ other \_\_\_\_\_

\_\_\_ In performing the patient set-up, the student was **lacking in confidence and/or skill** with (check all that apply): 1(5), 2(4), 3(3)

\_\_\_ more than one or two minor OR one major hesitation(s) or uncertainty(ies)

\_\_\_ more than one or two minor OR one major instance(s) requiring assistance from the clinical instructor

\_\_\_ more than one or two minor OR one major question(s) being asked

\_\_\_ other \_\_\_\_\_

\_\_\_ In performing the patient set-up, the student exhibited carelessness, lack of attention to detail, little self-confidence, and **should repeat the procedure** (0)

## 2021-2022 Clinical Competency Requirements

General Patient Care	Date Completed	Competence Verified By
CPR-BLS		
Vital Signs (BP, pulse, respiration, temperature)		
O <sub>2</sub> Administration		
Patient Transfer		
Quality Control Procedures		
1. Linear Accelerator		
- Laser Alignment		
- Beam Output and Symmetry		
2. Simulator		
- Laser Alignment		
Simulation Procedures		
1. Brain		
2. Head and Neck		
3. Chest		
4. Breast		
5. Abdomen		
6. Pelvis		
7. Skeletal		
Dosimetry		
1. Single Field		
2. Parallel Opposed Fields		
3. Weighted Fields		
4. Wedged Fields		
5. Computer Generated Isodose Plan		
6. Electron Field		
Treatment Accessory Devices		
1. Custom Block (Photon or Electron)		
2. Custom Bolus		
3. Custom Immobilization Devices for Thorax or Abdomen/Pelvis		
4. Thermoplastic Mold		
Participatory Procedures		
1. Total Body Irradiation (TBI)		
2. Craniospinal		
3. Brachytherapy		

Radiation Treatment Procedures	Mandatory	Elective
Brain		
	1. Primary	
	2. Metastatic	
Head and Neck		
		3. Laterals Only
	4. Multiple Fields to include Supraclavicular	
Chest		
	5. Multi-field (non-IMRT)	
	6. IMRT and/or arc therapy	
Breast		
	7. Tangents Only	
	8. Tangents with Supraclavicular	
		9. Tangents with Supraclavicular and Posterior Axilla Boost
		10. Tangents with Supraclavicular and Internal Mammary
Abdomen*		
	11. Multi-field (non-IMRT)	
	12. IMRT and/or arc therapy	
		13. Para-Aortic
Pelvis*		
	14. Multiple Field Supine	
	15. Multiple Field Prone	
		16. Inguinal
Skeletal		
	17. Spine	
	18. Extremity	
Electron Fields		
	19. Single	
		20. Abutting Fields

**Multi-field includes two more fields, and may include 3D conformal, IMRT and/or arc therapy (unless specified otherwise). \*Abdomen and Pelvis do not include treatments for metastatic disease.**

## **RTT 596 Research Methodology and Design Statistics II**

Spring 2022

Course Instructor

Matthew R. Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

Phone: (984) 974-8629

E-mail: Matthew.Hawkins@unchealth.unc.edu

Thursday (1:00 p.m. – 4:00 p.m.); 37.5 contact hours (3 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

This course is a continuation of RTT 595 with projects finalized.

Prerequisite: A grade of C or better in RTT 595.

### Required Text and Handout Materials

Handouts are designed to guide the student through the course.

### Grading and Assignments

The grading for this course is different from other courses. Course grades are subject to quality and must be submitted by the required deadlines. These deadlines are discussed during the first class. Primary classroom activities are independent research, writing, and individual and collective meetings. It is the student's responsibility to manage his/her time wisely, as the course is predominantly independent study. The student is required to meet a minimum of 3 times for one-on-one instructor evaluation. It is the student's responsibility to schedule these dates and times.

Note: A grading rubric will be given to the student.

### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

### Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct. Your acceptance of enrollment presupposes a commitment to the principles embodied in the code of student conduct.

## **RTT 550 Radiation Oncology**

Fall 2021 and Spring 2022 (first and second semesters)

Course Instructors:

Matthew R. Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

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Elaine M. Zeman, PhD

Associate Professor

UNC Department of Radiation Oncology

Physician's Office Building

Phone: (919) 843-7590

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Thursday (9:30 a.m. – 12:00 p.m.); 37.5 contact hours (3 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

*This two-semester course covers the biological underpinnings, pathological and clinical characteristics, and management of benign and malignant tumors commonly treated with radiation therapy. Tumor epidemiology, risk factors and symptoms, diagnosis, staging, modes of spread, treatment and survival rates will be discussed.*

The first semester will be devoted to the more common malignancies seen at UNC Radiation Oncology and be taught by radiation biologist Dr. Elaine Zeman. As such, special emphasis will be placed on the biological underpinnings of these cancers, and cutting-edge molecular diagnostic methods, targeted therapies and emerging radiotherapy techniques.

The second half of the course will cover the remaining benign and malignant tumors, and is taught primarily by Matthew Hawkins.

Prerequisite: Admission to the UNC Hospitals Radiation Therapy Program.

## Required Textbook and Handout Materials

Textbook: *Principles and Practice of Radiation Therapy, Fifth Edition* by C.M. Washington and D. Leaver (Mosby, St. Louis, 2020). **Note: New Edition**

Dr. Zeman's class handout materials will be available digitally, and can be obtained from a cloud-based folder. Dr. Zeman will e-mail participants links to download new handouts as they are made available.

*These lecture materials are considered the intellectual property of the course instructor and should not be shared with ANYONE outside of the Department.*

## Grading and Assignments

Grades on quizzes at the conclusion of each teaching module – a total of five during Summer-Fall semester – will be added to those for the Winter-Spring semester, and averaged. This will constitute 80% of the total course grade.

The grading scale will be as follows:

97 and up	A+
93 – 97	A
90 – 93	A-
87 – 90	B+
83 – 87	B
80 – 83	B-
77 – 80	C+
73 – 77	C
70 – 73	C-
Below 70	F

**Students must achieve a grade point average of at least 70% in order to pass the course.**

Grades based on three oral presentations on interesting clinical cases (case studies) will constitute the remaining 20% of the course grade.

## Attendance and Special Assistance

Course attendance is mandatory. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances. *Any student who feels the need for extra support for studying or test taking should notify the instructor(s) as soon as possible.*

## Honor Code

*The University of North Carolina's Honor Code is recognized and enforced in this course.* The principles of academic honesty, integrity and responsible citizenship govern the performance of all academic work and student conduct at the University. Your acceptance of enrollment presupposes a commitment to the principles embodied in the Code of Student Conduct.

If you have any questions about your responsibility, or the responsibility of your faculty instructors under the Honor Code, please contact the Office of Student Conduct (919-962-0805, <https://studentconduct.unc.edu/>), or the Office of the Dean of Students (919-966-4042, <https://odos.unc.edu/>).

## Scheduling Notes:

- No classes on Tuesday and Thursday, November 23 and 25 (Thanksgiving week)

## **RTT 550 (first semester)**

### *Lecture Schedule*

#### Module 1      CELL, TISSUE AND CANCER BIOLOGY

Introduction and cell biology review

Normal tissue biology/cell types in various tissues

Cancer biology

“Hallmarks” of cancer

Cancer staging and grading

Cancer epidemiology

Readings: Handout; Chapter 1, “*Cancer: An Overview*”

### **Quiz #1 – Cell, Tissue and Cancer Biology**

#### Module 2      LUNG CANCER

Introduction/epidemiology/socioeconomic impacts

Tobacco, asbestos, and other risk factors

Small cell lung cancer (SCLC)

Non small cell lung cancer (NSCLC)

Mesothelioma

Carcinoid tumors

Readings: Handouts; Chapter 28, “*Respiratory System Tumors*”

**Quiz #2 – Lung Cancer**

Module 3 FEMALE REPRODUCTIVE SYSTEM CANCERS

Introduction/epidemiology/risk factors

Cervix

Endometrium

Vagina/vulva

Ovaries/Fallopian tube/primary peritoneal

Readings: Handouts; Chapter 32, “*Gynecologic Tumors*”

**Quiz #3 – Female Reproductive System Cancer**

Module 4 HEAD AND NECK CANCERS

Introduction/epidemiology/risk factors

Nasal cavity/paranasal sinuses

Nasopharynx

Oral cavity/oropharynx

Salivary glands

Larynx/hypopharynx

Readings: Handouts; Chapter 29, “*Head and Neck Cancers*”

**Quiz #4 – Head and Neck Cancer**

Module 5      BREAST CANCER

Introduction, history and epidemiology/risk factors

Breast cancer types and subtypes; molecular biology of breast cancer

Controversies in breast cancer

Treatment of primary and metastatic breast cancer

Readings: Handouts; Provided articles; Chapter 34, “*Breast Cancer*”

**Quiz #5 – Breast Cancer**

**RTT 550 (second semester)**

*Lecture Schedule*

HODGKIN AND NON-HODGKIN LYMPHOMAS

LEUKEMIAS

ENDOCRINE CANCERS

CENTRAL NERVOUS SYSTEM CANCERS

GASTROINTESTINAL CANCERS

MALE GENITOURINARY AND REPRODUCTIVE SYSTEM CANCERS

PEDIATRIC CANCERS

SKIN CANCERS

PRIMARY BONE/SOFT TISSUE SARCOMAS

METASTATIC CANCER

BENIGN TUMORS

Readings: Respective chapters in Washington & Leaver

## RTT 92 Medical Radiation Therapy Physics II

Spring 2022

Course Instructor

Matthew R Hawkins, MHA, CMD R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

Phone: (984) 974-8629

E-mail: Matthew.Hawkins@unchealth.unc.edu

Tuesday (9:30 a.m. – 12:00 p.m.); 37.5 contact hours (3 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

This course teaches basic theories and calculations for radiation oncology. This course covers the following topics: radiologic physics, production of x-rays, simulation and radiation treatment machines, interactions of ionizing radiation, radiation measurements, dose calculations, computerized treatment planning, dose calculation algorithms, electron beam characteristics, and brachytherapy physics and procedures. In addition, imaging for radiation oncology, IMRT, stereotactic radiosurgery, special procedures, particle therapy, hyperthermia, and radiation safety are discussed.

Prerequisite: A grade of C- or better in RTT 90

### Required Text and Handout Materials

Stanton, Stinson. *Applied Physics for Radiation Oncology*.

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Test performance                      70%

Homework (questions)                30%

*Lecture Topics*

Section 1: Radiologic Physics

Atomic and Nuclear Structure

- A. Atomic structure
  - 1. Rest mass
  - 2. Energy
  - 3. Fundamental principles
  - 4. Atomic structure
  - 5. Atomic binding energy
  - 6. Atomic shell filling rules
  - 7. Transitions
  - 8. Energy level diagrams
  - 9. Characteristic radiation
  - 10. Auger electrons
  - 11. Fluorescent yield
- B. Nuclear structure
  - 1. Mass, atomic, and neutron number
  - 2. Periodic Table of Elements
  - 3. Nuclear binding energy
  - 4. Fission, fusion
- C. Radioactive decay
  - 1. Modes of decay
  - 2. Special types of nuclides
  - 3. Mathematics of radioactive decay
  - 4. Equilibrium
  - 5. Natural radioactivity

Production of X-rays

- A. X-ray tubes
  - 1. Anode and cathode
  - 2. Focal spot size
  - 3. Reflection and transmission targets
  - 4. Heel effect
  - 5. X-ray emission spectrum
  - 6. Factors that affect the x-ray emission spectrum
  - 7. X-ray circuits
- B. Physics of x-ray production

1. Bremsstrahlung
  2. Characteristic x-rays
  3. X-ray energy spectra
  4. Operating characteristics
- C. Simulators
1. Conventional simulators
  2. CT simulators

## Radiation Treatment and Simulation Machines

- A. Kilovoltage units
- B. Linear accelerators
  1. Major subsections
  2. Accelerator section
  3. Microwave power (magnetron, klystron)
  4. Bending magnet types
  5. Monitor chamber
  6. Photon beam production
    - a. Target
    - b. Flattening filter
    - c. Collimation (including multileaf collimators)
    - d. Beam profiles (“horns”)
  7. Computer control system
  8. Electron beam production
    - a. Scattering foil systems
    - b. Scanning electromagnet systems
    - c. Collimation
- C. New machines
  1. ViewRay
  2. Vero

## Interactions of Ionizing Radiation

- A. Types of electromagnetic radiation
- B. Properties of photons, relationship of energy and wavelength
  1. Direct and indirect ionizing particles
- C. Photon interaction process, KERMA
  1. Attenuation and absorption coefficients
    - a. Attenuation coefficients
    - b. Transfer coefficients
    - c. Absorption coefficients
- D. Relationship of KERMA and absorbed dose

- E. Attenuation in the body
- F. Modes of interaction
  - 1. Coherent scattering
  - 2. Photoelectric absorption
  - 3. Compton scattering
  - 4. Pair production
  - 5. Triplet production
  - 6. Photodisintegration
  - 7. Energy dependence of interaction probabilities
  - 8. Attenuation in the human body
- G. Interaction of particle radiation
  - 1. Heavy charged particles
  - 2. Interactions of electrons
  - 3. Interactions of neutrons

#### Radiation Measurements

- A. Photon and energy flux density and fluence
- B. The Roentgen
- C. Electronic equilibrium
- D. Ionization chambers
  - 1. Free-air chambers
  - 2. Thimble chambers
  - 3. Condenser chambers
    - a. Stem effect
  - 4. Farmer chambers
  - 5. Parallel-plate chambers
  - 6. Extrapolation chambers
  - 7. Diode detectors
  - 8. Electrometers
    - a. Integrate mode
    - b. Rate mode
- E. Exposure calibration of x-ray or gamma-ray beams
  - 1. Selection of calibration variables
  - 2. Selection of chamber
  - 3. Positioning of chamber
  - 4. Corrections to readings

#### External Beam Dosimetry Concepts

- A. Dosimetric variables
  - 1. Inverse square law

2. Backscatter factor
3. Peak scatter factor
4. Electron buildup
5. Percent depth dose
  - a. Mayneord f-factor
  - b. TAR correction to f-factor
6. Equivalent squares
7. Tissue air ratio
8. Scatter air ratio

### System of Dose Calculations

- A. Monitor unit calculations
  1. Output factor
  2. Field size correction factors
  3. Collimator scatter factor and phantom scatter factor
  4. Beam modifier factors
  5. Patient attenuation factors
- B. Calculations in practice
  1. SSD technique
    - a. SSD treatment same as SSD of calibration
    - b. SSD treatment different from SSD of calibration
    - c. SSD treatment and SAD calibration
  2. SAD technique
    - a. SAD treatment and SAD calibration
    - b. SAD treatment and SSD calibration
    - c. SAD rotational treatment
- C. Beam weighting
- D. Arc rotation therapy
- E. Irregular fields

### Computerized Treatment Planning

- A. Isodose curves (beam characteristics)
- B. Skin dose
- C. Parallel opposed beam combination
- D. Wedge isodose curves
  1. Wedge angle and hinge angle
  2. Wedge factor
- E. Wedge techniques
  1. Wedge pair
  2. Open and wedged field combination

- 3. Skin compensation
- F. Beam combination (3-, 4-, 5- etc. field techniques)
- G. Dose-volume specification
  - 1. ICRU 50
    - a. GTV, CTV, PTV
    - b. Organs at risk
    - c. Dose specification
  - 2. ICRU 62
    - a. ITV
    - b. Planning risk volume
    - c. Conformity index

### Electron Beam

- A. Depth dose/isodose characteristics
  - 1. AAPM TG-25
- B. Treatment planning with electrons
  - 1. Rules of thumb
  - 2. Selection of energy, field size
  - 3. Electron skin dose
  - 4. Electron bolus
  - 5. Electron field shaping
- C. Field matching
  - 1. Electron-electron gapping
  - 2. Electron-photon gapping
- D. Electron backscatter
- E. Inhomogeneities and electrons

### Dose Calculation Algorithms

- A. Basic dose algorithms
  - 1. Generation of isodoses
  - 2. Irregular fields
- B. Corrections for inhomogeneities
  - 1. Simple 1-D and 2-D methods
  - 2. Convolution methods
  - 3. Monte Carlo methods
  - 4. Dose perturbations at interfaces

### 3D CRT Including ICRU Concepts and Beam Related Biology

- A. 3D CRT concepts – volumetric (3D CRT) vs. non-volumetric
  - 1. Technology and methods for planning (volume-based planning)

2. Building patient models (image reconstruction and segmentation)
3. Virtual simulation
4. Implications of treatment variabilities
  - a. Systematic and random set-up variability, patient breathing
  - b. Contouring variability
- B. Volumetric beam placement
  1. DRR generation
  2. BEV, DVH
  3. Non-coplanar beams
  4. Planning tools
    - a. Biological implications of uniform vs. non-uniform dose delivery
    - b. Non-biological and biological dose-volume metrics (DVHS, TCPs, NTCPs)
    - c. Margins (PTVs, PRVs)
- C. Treatment planning methods
  1. Beam selection
  2. 4D imaging and planning
  3. Dose reporting
  4. Volumetric vs. point prescriptions

#### Adjoining Fields and Special Dosimetry Problems

- A. Two-field problem
- B. Three-field problem
- C. Craniospinal gapping
- D. Peripheral dose
- E. Pacemaker
- F. Gonadal dose
- G. Pregnant patient
- H. Surface dose

#### Imaging for Radiation Oncology: MRI

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

#### Imaging: Nuclear Medicine, Ultrasound, EPID

- A. Ultrasound
  1. Physical principles

- a. Utility in diagnosis and patient positioning
  - b. PET imaging
- B. PET
  - 1. Physical principles
    - a. Utility for radiation therapy
    - b. SPECT
- C. Electronic Portal Imaging
  - 1. Overview of electronic portal imaging devices
  - 2. Types of portal imaging devices
  - 3. Clinical applications of EPID technology in daily practice

#### Imaging: Radiographic, CT, 4D

- A. Diagnostic imaging
  - 1. Physical principles
  - 2. Port film imaging
  - 3. Film based
  - 4. XV-2 film, EDR-2 film characteristics
- B. CT
  - 1. Physical principles
    - a. Serial, helical
    - b. Hounsfield units, CT numbers, inhomogeneity corrections based on CT scan images

#### Imaging: Fusion, Image Registration

- A. Image fusion
  - 1. Advantages
  - 2. Challenges
  - 3. Techniques
  - 4. Limitations
- B. Deformable body/structure image fusion
- C. Quality assurance
  - 1. Image transfer process, accuracy, fidelity
  - 2. Image fusion process

#### IMRT

- 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, and 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
    - a. How to distinguish a good IMRT plan vs. 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.)

#### Informatics

- A. DICOM
- B. PACS
- C. Network integration and integrity
- D. Storage and archival
- E. IS maintenance

#### Stereotactic Radiosurgery

- A. SRS delivery system
  - 1. Linac based
  - 2. Gamma Knife
  - 3. Robotic linac
- B. Simulation and immobilization/repositioning
- C. Dose prescription and treatment planning
- D. Treatment calculations
- E. SRS quality assurance

#### Particle Therapy

- A. Protons
  - 1. Proton beam energy deposition
  - 2. Equipment for proton beam therapy
  - 3. Clinical beam dosimetry

4. Clinical proton beam therapy
  5. Treatment planning
  6. Treatment delivery
  7. Clinical applications
  8. Clinical beam dosimetry
- B. Other particles
1. Carbon
  2. Neutrons
- C. Biology
1. LET
  2. 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

RTT 92

### *Homework Questions*

Note: All answers must be typed. There is a 5% reduction in grade for each 24 hour period from the due date. All due date times are 4:00 p.m. of the date assigned.

### Atomic and Nuclear Physics

**Due: November 30, 2021**

1. How do atomic and nuclear energy levels differ?
2. Are atomic energy levels defined absolutely or in terms of probability? Explain your answer.
3. What is the  $Z$  number?
4. What does  $A$  represent?

5. What dose X represent?
6. What is the relationship between the number of neutrons and protons in stable nuclei?
7. What is the relationship between wavelength and frequency?
8. Are x-rays electromagnetic radiation?
9. What type of model is used to understand electromagnetic radiation?
10. What energy equation is used in terms of wavelength/frequency?
11. Give definition of the following terms:
  - a. Activity
  - b. Half life
12. Define the two terms and construct a model demonstrating transient and secular equilibrium.
13. When would radioactive equilibrium be achieved?
14. Describe positron emission and annihilation.
15. Is electron capture an alternative process to positron decay or negatron decay?
16. Define the process of internal conversion.
17. What is isomeric transition?
18. Distinguish between x and gamma rays.
19. Explain the difference between indirectly and directly ionizing radiation.
20. Determine whether x-rays and electrons are indirectly ionizing radiation, directly ionizing radiation, or both.
21. Define the following terms:
  - a. Exposure
  - b. Absorbed dose
  - c. Roentgen
  - d. cGy
  - e. Becquerel
  - f. Isotope
  - g. Isomer
  - h. Isobar
  - i. Isomers
  - j. Atomic mass unit
  - k. Avogadro's Law
  - l. Mass defect
  - m. Binding energy of the nucleus
22. What is the formula that is the principle of equivalence of mass and energy?
23. What force does the strong nuclear force overcome that keeps the nucleus together?
24. What are the three series of radioactive elements?

### Types of Radiation

**Due: December 15, 2021**

1. What is ionizing radiation?
2. What is the lowest kinetic energy to call a type of radiation ionizing?
3. List the x-ray energies for the following radiation therapy terms:
  - a. Grenz
  - b. Contact
  - c. Superficial
  - d. Orthovoltage
  - e. Megavoltage
4. What is the energy of a photon with the wavelength 0.001 nm?
5. What is the approximate range of alpha particles in tissue?
6. What is the energy range of protons in radiation therapy?
7. What is the approximate range in water of 150 MeV protons? 300 MeV deuterons? 100 MeV negative pions?
8. Is the Bragg peak for a pion sharper or broader than for a proton?

### Radiation Machines

**Due: January 11, 2022**

1. Which emits electrons, the cathode or the anode?
2. Are both the cathode and anode sealed in the glass tube and at high vacuum?
3. Which material is commonly used for the target?
4. Why is the target placed at an angle?
5. Why does the target rotate?
6. Name three designs for cooling of the target.
7. Are most modern x-rays systems self-rectified or fullwave rectified? Why?
8. What is the approximate efficiency of bremsstrahlung production in a 100 kVp system? What happens to the rest of the energy?
9. Does an x-ray tube produce monoenergetic photons or a spectrum of energies?
10. Why are diagnostic x-rays systems filtered?
11. The medical linear accelerator uses high power \_\_\_\_\_ waves to accelerate \_\_\_\_\_ particles to high energies.
12. Most accelerators today use the \_\_\_\_\_ wave design.
13. The thyatron is essentially a very high-power switch, and is used in the \_\_\_\_\_ to produce short pulses of high voltage, which are delivered to the \_\_\_\_\_ (or \_\_\_\_\_) and to the electron gun simultaneously.
14. Is the magnetron or klystron more commonly used in high energy linacs? Why?
15. Why is a flattening filter necessary for x-ray mode and scattering foils for electron mode?
16. What type of beam is most commonly produced in the cyclotron for radiation therapy?
17. Why is Co60 used as the only isotope teletherapy machine (think of the physical characteristics – half life, gamma, energy, specific activity)?

## Interaction of Radiation with Matter

**Due: February 1, 2022**

1. What is ionization and how is it different from excitation?
2. How do photons ionize atoms?
3. If the half value layer of a photon beam is 5 cm in water, what is  $\mu$ ?
4. Is each successive half value layer equal to the preceding half value layer from a Cs137 source?
5. Briefly describe the photoelectric effect. How does the intensity of the photoelectric process vary with E? with Z?
6. Describe briefly the Compton effect. Does the photon stop and transfer all its energy? How does the Compton effect vary with Z? with electron density? with E?
7. Write the formula for the energy of the Compton scattered proton. What is the energy of a 5 MeV photon after scattering through an angle of 30 degrees? after an angle of 90 degrees?
8. Briefly describe the pair production process. What is the threshold energy for this process? Why are pair production events at this energy almost never seen in clinical applications? How does pair production vary with Z?
9. What is KERMA? How does it differ from absorbed dose? Which value is higher near the surface for a megavoltage beam?
10. What is the traditional unit of exposure? Is it formally defined for a 25 MV photon beam?
11. Graphically compare the measurement conditions for PDD, TAR, and TPR.
12. Where is field size defined for each measurement? Which parameter shows an inverse square effect?
13. Why would we be concerned about underdosing at the edge of a tumor which protrudes into the lung if treating with an 18 MV beam?
14. Do electrons interact with matter by processes similar to photons? Explain your answer.
15. When comparing the variation in effective beam energy with depth for a photon and electron beam, which beam becomes harder and why?
16. What is the approximate rate of energy change of megavoltage electrons in water?
17. Which beam would deliver a higher surface dose, 18 MeV or 7 MeV?
18. Why do we use applicators to collimate the electron beams almost all the way to the patient surface, but not for photons?
19. What would be the potential disadvantage of a lead sheet on the skin when treating a lesion close to a critical structure?
20. Assume you were planning an electron beam treatment to the left chest wall scar, and the beam geometry was such that the exit path would traverse bone (chest wall) then lung, then heart. If the determination of chest wall depth showed large variations and you would prefer to use 16 MeV rather than 9 MeV to ensure full coverage with the 90%

isodose line, which physical effects of electron beam interactions should you reconsider?  
Name at least two.

### Measurement of Megavoltage Radiation Rotation

**Due: March 1, 2022 (all four sections below)**

1. Why must ionization chamber walls be “air equivalent?”
2. What are the outer dimensions of the farmer chamber’s collecting volume?
3. If we wanted to check depth dose on isodose distributions, but did not have a scanning water tank system, which solid state dosimetry method would be most convenient?
4. If we used film for dosimetric measurements, which resolution would be worse, spatial resolution or dose resolution?
5. List five types of dosimetric data that we would need to measure in order to provide complete and accurate 2D dose calculations for all types of photon and electron fields?
6. How is the wedge angle defined? Is it the physical wedge’s angle?

### Mathematical Modeling of Measured Doses

1. Would you need to perform a scatter integration for an asymmetric field with no blocks? Explain.
2. What is head scatter and why does its value increase with field size?
3. What is tissue reference ratio (TRR), what physical processes are included in this factor, does the TRR have units, and how does it differ from TMR and TPR?
4. Does a national standard exist for the calculation of meter sets?
5. Why does the beam profile change with depth? Do all centers account for this in their meter set calculations?
6. Is the wedge factor a single, constant value for each wedge? Explain.
7. What would be some of the practical problems with treatment planning CT scans in the radiology CT scanner?
8. Describe the differences between 2-D, 2.5-D, and 3-D treatment planning.
9. The AAPM TG 40 report defines the accuracy goal in radiation oncology to 5% overall. From the following four steps, state the uncertainty in percentage:
  - a. Localization
  - b. Simulation
  - c. Dosimetry
  - d. Oncologists
  - e. Treatment
10. How much uncertainty is allowed in patient data measurements?
11. Define the following terms:
  - a. Gross tumor volume
  - b. Clinical target volume

- c. Planning target volume
- d. Treatment volume

### Alpha and Omega

1. Describe the variation of  $d_{max}$  with field size.
2. How does the depth dose change with increasing TSD?
3. What would be an advantage and a disadvantage of treating a mantle technique with 18 MV?
4. If a patient had a separation of 30 cm, would 18 MV or 6 MV be a better treatment energy and why?
5. If a target volume is centered in the body and treated AP/PA, and the tumor volume extends to 1 cm from the field edges, would the entire target volume receive 100% of the treatment dose? Why?
6. When two fields are at 90 degree angles relative to each other, would the resulting dose distribution be uniform in the intersecting volume? Using the antiquated hinge angle formula, what would your calculated wedges be?

### External Electron Beams

1. How does surface dose vary with electron beam energy?
2. How does electron depth dose change with increasing TSD?
3. What would be a good rule of thumb for lateral distance from the light field edge to the 90% isodose line?
4. Based on #3 above, what would be the smallest advisable light field dimension for assuring a reliable daily dose to a measurable area?
5. Can the photon field matching formula be applied to electron beams? What are the depths: 90%, 80%, and 0%?

### Brachytherapy

1. Calculate the exposure rate produced by a 15 mg radium source at a distance of 30 cm.
2. Draw how an anisotropic distribution would look emanating from a radium source.
3. Calculate the activity of Co60 needed to produce the same exposure as 20 mg radium.
4. A radium treatment consists of 1200 mg-hrs. If the same treatment is given using 30 mCi of Cs-137, how long will the implant last?
5. If 1200 mg-hrs are needed to complete the implant in #4 above, how much gold would be required (for a permanent implant)?
6. A radon source is left on a counter for several months. Calculate the total exposure to appoint in the next room if the initial rate was 12 mR/hr.

## RTT 97 The Radiobiology of Radiotherapy

Spring 2022 (second semester)

This course, taught by a PhD radiation biologist, covers the theories and concepts related to the molecular, cellular, tissue and organism-level effects of exposure to ionizing radiation, and how these relate to the practice of radiation therapy.

### Course Instructor:

Elaine M. Zeman, Ph.D.  
Associate Professor  
Department of Radiation Oncology  
UNC School of Medicine

Phone: 919-843-7590

E-mail: elaine\_zeman@med.unc.edu

Office: Room B127, Physicians Office Building  
Hours Available: after class on Tuesdays, or else Monday-Thursday afternoons  
with some advanced notice

### Course Schedule:

Two sessions per week: Tuesdays and Thursdays, 1:00 ~ 2:00 pm  
Radiation Oncology Manning Level Classroom

### Textbooks:

Dr. Zeman's class handout materials will be available digitally, and can be obtained from a cloud-based Dropbox. Dr. Zeman will e-mail participants direct links to download the handouts as they are made available.

*These lecture materials are considered the intellectual property of the course instructor and should not be shared with ANYONE outside of class.*

### Supplemental Reading:

*Principles and Practice of Radiation Therapy, Fifth Edition* by C.M. Washington and D. Leaver (Mosby, St. Louis, 2020). **Note: New Edition**

*Radiologic Science for Technologists: Physics, Biology and Protection, Tenth Edition* by S.C. Bushong (Mosby, St. Louis, 2013). Sections on radiation protection (multiple chapters)

### Exams and Grading:

Three quizzes and a final exam will be given during the course at approximately monthly intervals, with each quiz intended to test knowledge of the material presented since the previous quiz. The final exam will also largely emphasize the most recent material presented, however will also include a few questions related to earlier parts of the course. The final exam is also “weighted” to count as the equivalent of two quizzes, because it will be a longer test.

***The lowest quiz score will be dropped when calculating the final grade.*** (And since the final counts as two quizzes, if the final exam score is the lowest, only one score will be dropped.)

Exam questions will consist of multiple-choice, true-false, “fill in the blanks” and “short answer/brief definition” formats. In addition, two or three problem solving, graph interpretation, and/or essay-type questions will be included on each exam.

The grading scale will be as follows:

97 and up	A+
93 – 97	A
90 – 93	A-
87 – 90	B+
83 – 87	B
80 – 83	B-
77 – 80	C+
73 – 77	C
70 – 73	C-
67 – 70	D+
63 - 67	D
Below 63	F

***In order to pass the course, the student must achieve an average score (across all quizzes) of at least 70%.***

### Attendance and Special Assistance:

Course attendance is considered mandatory. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances. Any student who feels the need for extra support for studying or test taking should notify the instructor as soon as possible.

### Honor Code:

*The University of North Carolina’s Honor Code is recognized and enforced in this course.* The principles of academic honesty, integrity and responsible citizenship govern the performance of all academic work and student conduct at the University. Your acceptance of enrollment presupposes a commitment to the principles embodied in the Code of Student Conduct.

If you have any questions about your responsibility, or the responsibility of your faculty instructors under the Honor Code, please contact the office of the Student Attorney General (966-4084), or the Office of the Dean of Students (966-4041).

## Course Outline and Objectives:

### *Introduction; Radiation Chemistry; Free Radical Reactions*

1. What is radiobiology?
2. *Cell biology review.*
3. The interaction of ionizing radiation with biological materials.
  - a) sources of “background” radiation
  - b) high versus low LET radiations
  - c) the radiolysis of water
  - d) free radical chemistry
  - e) cellular targets for radiation damage
  - f) direct and indirect effects of radiation
  - g) radiation damage to DNA
  - h) the radiochemistry of the oxygen effect

### *The "Take Home" Messages:*

1. Define what radiobiology is, and how it applies to the practice of radiation oncology.
2. Know the average amount of background radiation everybody (in the US) is exposed to annually, and what the contribution is from natural versus man-made sources.
3. Describe how free radicals are formed and identify some reactions of the free radicals derived from water radiolysis.
4. Describe the effect of LET on radiation interactions at the chemical level.
5. Understand the difference between the direct and indirect effects of ionizing radiation in biological systems.
6. Know the types of DNA damage caused by ionizing radiation and how these might be related to chromosomal damage.

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*Cellular Response to Radiation*

1. Consequences of DNA damage.
  - a) enzymatic repair of damage vs. tolerance of damage
  - b) human diseases related to DNA repair deficiencies
  - c) chromosome aberrations
  
2. Fate of irradiated cells.
  - a) reproductive or mitotic death
  - b) interphase death or apoptosis
  - c) division delay
  - d) mutation
  - e) neoplastic transformation and carcinogenesis
  
3. Cell survival curves.
  - a) what is *really* meant by "cell death"?
  - b) survival curve models and parameters
  - c) partial response vs. complete response vs. tumor cure
  
4. Tissue dose response curves.
  - a) are cell survival curves representative of what is going on in tissues?
  - b) dose response relationships for normal tissues
  - c) dose response relationships for tumors
  
5. Cellular "repair".
  - a) sublethal damage recovery (SLDR)
  - d) potentially lethal damage recovery (PLDR)
  - c) repair and fractionation in radiotherapy
  - b) age response through the cell cycle
  - e) radiation-induced cell division delay

*The "Take Home" Messages:*

1. Know the possible fates of cells that have been irradiated with ionizing radiation.
2. Be able to recognize major types of chromosome aberrations and their possible consequences to the cell.
3. Understand the function of a cell survival curve and be able to recognize, label and explain major components of the curves.

4. Estimate the relative radiosensitivities of two different cell types from their cell survival curves.
5. Know the difference between a cell survival curve and a tissue dose response curve.
6. Know the difference between a clonogenic and non-clonogenic assay of tissue dose response, and be able to give examples of each for both tumors and normal tissues.
7. Identify and explain factors that affect cellular recovery from radiation damage.

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*Basic Tissue Response to Radiation*

1. A review of different cell and tissue types in the human body.
2. Laws of Bergonié and Tribondeau.
3. Cell populations and normal tissue organization before and after irradiation.
4. Growth patterns of tumors before and after irradiation.

*The "Take Home" Messages:*

1. Be able to recite the laws of Bergonié and Tribondeau, and understand how these translate into the "VIM and DIM" and "hierarchical and flexible" tissue radiosensitivity classification systems.
2. Know the definition of a "target cell", along with the types of target cells that have been identified for different normal tissues.
3. Develop a basic understanding of what genetic events cause normal cells to become cancerous, what properties or "behaviors" are characteristic of cancer cells, how tumors grow and how this is measured clinically.
4. Understand the meaning of, and difference between, cancer prevalence and prognosis; be able to identify the most prevalent cancers and their relative prognoses.

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*Early and Late Effects in Normal Tissues*

1. Which effects are "early" and which "late"?
2. The acute, whole-body radiation syndromes.
  - a) prodromal syndrome

- b) cerebrovascular syndrome
- c) gastrointestinal syndrome
- d) hematopoietic syndrome

3. Radiation effects on the embryo and fetus: teratogenesis.

4. Radiation-induced cataracts.

5. Carcinogenesis as a late effect.

- a) second malignancies in radiotherapy patients
- b) radiation carcinogenesis in non-radiotherapy patients

6. Radiation protection: Terminology and exposure limits.

- a) genetic vs. somatic effects
- b) stochastic vs. non-stochastic ("deterministic")
- c) doses, dose equivalents and weighting factors
- d) cardinal rules of radiation protection

1] ALARA

2] GSD

3] NIREL

- e) exposure limits for radiation workers and the general public

*The "Take Home" Messages:*

1. Define the "mean lethal dose" ( $LD_{50/30}$ ).

2. State the approximate  $LD_{50/30}$  for humans, both with and without medical intervention.

3. Describe the set of exposure conditions that would lead to a "total body" radiation syndrome.

4. Identify the clinical stages of response in the total body radiation syndrome.

5. Be able to discuss the major radiation syndromes and identify the dose ranges over which they occur.

6. Understand the effects of radiation on an embryo or fetus, the approximate dose range over which these effects occur, and the time during gestation when the embryo or fetus would be most susceptible to these effects.

7. Be able to describe the features of radiation-induced cataracts that make them unique among early and late effects.
8. Be able to describe, and give numerical risk estimates for, the relationship between radiation exposure and the induction of fatal cancer.
9. Understand what epidemiology is, and its strengths and weaknesses.
10. Be able to name some of the human populations who were studied in terms of the possible cancer risk following radiation exposure.
11. Compare and contrast somatic and genetic radiation effects.
12. Understand the difference between stochastic and non-stochastic effects.
13. Be able to define the terms absorbed dose, dose equivalent, effective dose equivalent, collective dose equivalent, and genetically significant dose.
14. Know the pertinent radiation exposure limits that apply to you, your patients, and members of the general public.

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*Radiation Histopathology*

1. What is really meant by "tissue tolerance"?
2. Rubin and Casarett, Emami and QUANTEC tables of normal tissue complications and tolerance doses.
3. Radiation histopathology in major tissues and organs.
  - a) bone marrow
  - b) reproductive organs
  - c) intestinal mucosa
  - d) skin
  - e) kidney
  - f) lung
  - g) liver
  - h) vasculature
  - i) nervous system
  - j) miscellaneous
4. New directions in our understanding of tissue tolerance in radiotherapy.
  - a) how early and late effects change with fractionation pattern
  - b) how to use and compare  $\alpha/\beta$  ratios and BEDs
  - c) how changing the treatment volume affects normal tissue tolerance
  - d) normal tissue tolerance to re-irradiation

- e) methods for scoring early and late effects in normal tissues

*The "Take Home" Messages:*

1. List the four major categories of cell populations as defined by Rubin and Casarett, and give examples of each.
2. Know what is meant by " $TD_{5/5}$ " and " $TD_{50/5}$ ".
3. Know the different possible target cells in normal tissues, and the corresponding histological changes in the tissues caused by the loss of these cell types.
4. Be able to rank major organs by their relative radiosensitivities.
5. Be able to compare and contrast radiotherapy doses for tumor cure with those for normal tissue tolerance.
6. Develop a basic understanding of how normal tissue tolerances change with changes in dose fractionation patterns, and know what  $\alpha/\beta$  ratios and BEDs are used for.
7. Know how changing the irradiation volume affects normal tissue tolerance.
8. Understand some of the knowns and unknowns when it comes to normal tissue and tumor response to retreatment. In general, know which normal tissues are more or less able to tolerate retreatment.
9. Be aware of current methods for predicting tissue tolerance and scoring tissue effects (e.g., SOMA, CTCAE).

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*Radiobiology from a Clinical Radiotherapy Perspective*

1. The concept of therapeutic ratio.
2. Modification of cell and tissue response to ionizing radiation.
  - a) Physical
    - 1] time, dose, fractionation and isoeffect curves
    - 2] LET and RBE
    - 3] dose rate
    - 4] hyperthermia
  - b) Chemical
    - 1] radiosensitizers (including oxygen)

- 2] radioprotectors
- 3] bioreductive drugs
- 3. The problem of tumor hypoxia.
- 4. Radiation and chemotherapy interactions.
- 5. The "4 R's of Radiotherapy".
  - a) repair
  - b) repopulation
  - c) redistribution
  - d) reoxygenation

*The "Take Home" Messages:*

1. Understand the term therapeutic ratio, and be able to describe it both verbally and graphically.
2. Describe the biological rationales underlying variations in treatment techniques such as altered dose rate or fractionation, hyper- and hypofractionation, accelerated fractionation, hyperthermia, use of high LET radiation, etc.
3. Understand Strandqvist's isoeffect curves and how they formed the basis of the NSD model. Compare and contrast Strandqvist's curves with later ones that ultimately formed the basis of the  $\alpha/\beta$  isoeffect model.
4. Explain how oxygen and other radiosensitizers increase radiation damage to cells and tissues.
5. Define the oxygen enhancement ratio (OER), sensitizer enhancement ratio (SER), and dose reduction factor (DRF), and know how to calculate these factors from cell survival curves.
6. Explain how radioprotectors decrease damage to cells and tissues.
7. Rank the cell cycle phases in terms of radiosensitivity.
8. Describe cellular repair phenomena as they relate to radiation therapy.
9. State the "4 R's of Radiation Therapy", and discuss each in terms of the biological effects on the tumor and normal tissues.

## **RTT 532 Clinical Education in Radiation Therapy II**

Spring 2022

Course Instructors  
UNC and Duke registered radiation therapists

Monday, Wednesday, Friday (8:00 a.m. – 4:30 p.m.); 360 contact hours (6 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology

### Course Description

This is the second of a three course sequence. During the second course sequence, the student will complete clinical rotations. While in the clinical setting, the student observes and works directly with radiation therapists. Emphasis is given on learning and understanding the role and responsibilities of a radiation therapist in the clinical setting.

Prerequisite: A grade of C- or better in RTT 532

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Clinical competencies	45%
Clinical evaluations	40%
Weekly evaluations	10%
Self evaluations	5%

### *Objectives:*

1. To introduce the student to basic clinical operations
2. To introduce the student to various quality assurance procedures
3. To introduce the student to the performance of various clinical procedures, simulations linked with treatment planning
4. To allow the student to perform under direct supervision more complex set-ups
5. To demonstrate an understanding of the basic clinical concepts of radiation therapy
6. To demonstrate an understanding of theory and principles of operation of CT simulation and linear accelerator computers
7. To demonstrate an understanding of the different types of radiation production
8. To understand more complex radiation therapy set-ups
9. To demonstrate a basic understanding of treatment planning

10. To demonstrate an understanding of the role of a radiation therapist
11. To develop patient care, communication, and critical thinking skills with patients, healthcare providers, and patient support personnel
12. To monitor professional behaviors and alter clinical practice with regard to feedback from performance evaluations
13. To develop greater accountability and responsibility for patient safety

#### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

#### Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct. Your acceptance of enrollment presupposes a commitment to the principles embodied in the code of student conduct.

RTT 532

#### *Clinical Competencies/Observation Requirements*

1. During Semester II, the student must complete 10 competencies (20 total).
2. During Semester II, the student must observe 2 patient consults with a UNC Radiation Oncology medical resident.
3. During Semester II, the student must write up 5 case presentations from morning conference. These should be one page in length and include a description of the patient's set-up, treatment, and any special treatment delivery considerations.
4. During Semester II, the student must attend one Wednesday morning quality assurance meeting (9:45 a.m. – 11:00 a.m.; UNC Radiation Oncology Library).

## **RTT 560 Radiation Safety and Protection**

Fall 2021

Course Instructor

Matthew R Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

Phone: (984) 974-8629

E-mail: Matthew.Hawkins@unchealth.unc.edu

Tuesday: 1:00 pm – 3:30 pm Tuesday (25 contact hours, 2 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

This course is a continuation from didactic courses during first semester, Medical Dosimetry (RTT 94); and second semester, Medical Radiation Physics II (RTT 92) to this course in Radiation Safety and Protection. The content includes detection and measurement, source handling, survey methodology, maximum permissible doses, room design, and governmental regulations.

Prerequisites: A grade of at least a C- in didactic courses RTT 94 and RTT 92

### Required Text and Handout Materials

Kahn, *The Physics of Radiotherapy*.

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Test Performance      70%

Homework                30%

### *Objectives:*

1. To describe various radiation safety and protection issues
2. To describe and solve various radiation safety and protection quantitative problems
3. To understand the basic governance structure of radiation safety and protection in the United States and internationally

### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

### Honor Code

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RTT 560

### *Course Sequence*

#### Radiation Safety

- 1) Concepts and units
  - a) Radiation protection standards
  - b) Quality factors
  - c) Definitions for radiation protection
  - d) Dose equivalent
    - i) Units of dose equivalent
  - e) Effective dose equivalent
- 2) Types of radiation exposure
  - a) Natural background radiation
  - b) Man-made radiation
  - c) NCRP #91 recommendations on exposure limits
- 3) Protection regulations
  - a) NRC definitions
    - i) Recordable event
    - ii) Misadministration
  - b) NRC administrative requirements
    - i) Radiation safety program
    - ii) Radiation safety officer
    - iii) Radiation safety committee
    - iv) Quality management program
  - c) NRC regulatory requirements

#### Radiation Shielding

- 1) Treatment room design

- a) Controlled/uncontrolled areas
- b) Types of barriers
- c) Factors in shielding calculations
  - i) Workload (W)
  - ii) Use factor (U)
  - iii) Occupancy factor (T)
  - iv) Distance
- 2) Shielding calculations
  - a) Primary radiation barrier
  - b) Scatter radiation barrier
  - c) Leakage radiation barrier
  - d) Neutron shielding for high energy photon and electron beams
- 3) Sealed source storage
- 4) Protection equipment and surveys
  - a) Operating principles of gas-filled detectors
  - b) Operating characteristics
  - c) Radiation monitoring equipment
    - i) Ionization chamber (cutie pie)
    - ii) Geiger-Mueller counters
    - iii) Neutron detectors
  - d) Personnel monitoring

#### Treatment Planning Evaluation and Quality Assurance

- 1) Plan quality
  - a) ICRU definitions (max dose)
  - b) PTV coverage
  - c) OAR evaluation
- 2) Deliverability
  - a) Complexity
  - b) Uncertainties
  - c) Volatility
- 3) TP – quality assurance
  - a) TG-53
  - b) Review of images and targets
  - c) Review of beam data
  - d) VanDyk recommendations
  - e) Data transfer
  - f) TP disasters

#### External Beam Quality Assurance

- 1) Overview of quality assurance in radiation therapy
  - a) Goals
  - b) Staffing
    - i) Roles, training, duties, and responsibilities of individuals
  - c) Equipment selection and specifications
- 2) Linac and imaging quality assurance
  - a) Acceptance testing – linac
  - b) Commissioning – linac
    - i) Data required
    - ii) Computer commissioning
    - iii) Routing quality assurance and test tolerance
    - iv) Daily quality assurance
    - v) Monthly quality assurance
    - vi) Yearly quality assurance
  - c) Quality assurance of imaging apparatus
    - i) Portal imagers
    - ii) Linac-mounted real-time fluoroscopy units
    - iii) KVCT (cone beam) quality assurance testing
    - iv) MVCT quality assurance testing (TomoTherapy)
  - d) Dosimetric patient quality assurance
    - i) Dosimetry based
      - (1) Diodes
      - (2) TLDs
      - (3) MOSFETs

#### Calibration of Dose Output

- 1) Units of radiation dose, dose equivalent, and RBE dose
- 2) Calculation of dose from exposure
  - a) Converting exposure to absorbed dose in air
  - b) F-factor
  - c) Dose in free space
- 3) Measurement of absorbed dose with an ionization chamber
  - a) Stopping powers
    - i) Unrestricted stopping power
    - ii) Collisional stopping power ( $S_c$ )
    - iii) Radiative stopping power ( $S_r$ )
    - iv) Restricted stopping power
  - b) Bragg-Gray cavity theory
  - c) Spencer-Attix cavity theory
- 4) AAPM calibration protocols

- a) TG-51 protocol (photons and electrons)
- b) TG-61 protocol (superficial x-rays)

#### Other Measurement Systems

- 1) Film
  - a) Radiographic
  - b) Radiochromic
- 2) TLD
  - a) Phosphorescence
  - b) Thermoluminescence
- 3) Scintillation
- 4) Calorimetry
- 5) Gel/chemical dosimetry
- 6) Diode detectors

## **RTT 600 Seminars in Radiation Oncology**

Summer 2022

Course Instructor

Matthew R Hawkins, MHA, CMD, R.T.(R)(T)

Program Director

UNC Department of Radiation Oncology, UNC School of Medicine

NC Cancer Hospital, Radiation Oncology, Manning Level

Phone: (984) 974-8629

E-mail: Matthew.Hawkins@unchealth.unc.edu

Tuesday (9:30 a.m. – 12:00 p.m.) x 10 weeks (25 contact hours, 2 credit hours)

Location: NC Cancer Hospital, M level, Radiation Oncology classroom

### Course Description

This course reviews the major aspects of radiation therapy didactic and clinical practice primarily through examination and rhetorical review.

Prerequisite: Successful completion of Semester II (Spring)

### Required Text and Handout Materials

Handouts are designed to guide the student through the course.

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Practice exams            50%

Class participation      50%

### *Goals*

The philosophy of this course is to enhance for the student radiation therapist test-taking and evaluation skills and concepts required for a career in radiation therapy.

1. To develop skills in test-taking
2. To reinforce principles of foundations, radiation protection, dosimetry, physics, oncology, radiobiology, and quality assurance
3. To demonstrate effectiveness and efficiency while maintaining ethical standards
4. To evaluate the ARRT examination through content and percentage
5. To conceptualize the foundations of radiation therapy clinical practice

### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

### Honor Code

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## **RTT 533 Clinical Education in Radiation Therapy III**

Summer 2022

Course Instructors

UNC, Rex, and Duke registered radiation therapists

Monday, Wednesday, Thursday, Friday (8:00 a.m. – 4:30 p.m.); 360 contact hours (6 credit hours)

Location: UNC Hospitals, Rex Healthcare, and Duke University Hospital

### Course Description

This is the third of a three course sequence. During this final sequence, the student will complete assignments of higher complexity. The length of these rotations varies from 1 to 3 weeks. While in the clinical setting, the student will observe and work directly with radiation therapists. Emphasis is given on learning and understanding the role and responsibilities of radiation therapists in the clinical setting.

Prerequisite: A grade of C- or better in RTT 532

### Grading and Assignments

The course is graded A, B, C, D, or F. At minimum, the student must earn a grade of C- to remain in the program.

Clinical competencies            45%

Clinical evaluations            50%

Self evaluations            5%

In order to graduate, the student must have completed all required clinical competencies by August 1, 2015.

### *Objectives*

1. To introduce the student to advanced clinical operations
2. To teach the student advanced radiation therapy procedures
3. To introduce the student to various quality assurance procedures
4. To introduce the student to the performance of various clinical procedures, simulations linked with treatment planning: CyberKnife, brachytherapy
5. To allow the student to perform under direct supervision more complex set-ups
6. To demonstrate an understanding of the basic clinical concepts of radiation therapy set-ups and CT simulation

7. To demonstrate an understanding of theory and principles of operation of treatment computers
8. To demonstrate an understanding of the different types of radiation production
9. To understand higher integrated levels of patient safety
10. To demonstrate a basic understanding of treatment planning
11. To demonstrate an understanding of the role of the radiation therapist
12. To develop patient care, communication, and critical thinking skills with patients, healthcare providers, and patient support personnel
13. To monitor professional behaviors and alter clinical practice with regard to feedback from performance evaluations
14. To develop greater accountability and responsibility for patient safety

#### Attendance and Special Assistance

Course attendance is required. Absence will not be considered a valid excuse for failure to obtain the necessary information, except under the most unusual of circumstances.

#### Honor Code

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## **UNC Department of Radiation Oncology**

### **Facilities and Equipment**

The UNC Department of Radiation Oncology is located in the B and M levels of the NC Cancer Hospital. The primary didactic classroom is located within the UNC Department of Radiation Oncology. The student will train clinically in the UNC Department of Radiation Oncology as well.

1. The student is invited and encouraged to attend as many departmental functions as possible, such as the annual fall picnic and winter party.
2. Policies and procedures are posted within the department in their respective areas. All schedules, meetings, memos, etc. are posted either on the good news bulletin boards or e-mailed via the list serv.

The UNC Department of Radiation Oncology is comprised of approximately 50,000 square feet of work space within the NC Cancer Hospital. Equipment includes three conventional linear accelerators, a TomoTherapy unit, a CyberKnife, and a brachytherapy suite. The current treatment planning software is RayStation. The department is state-of-the-art and is one of only 36 recognized comprehensive cancer centers in the United States.

## **UNC Department of Radiation Oncology**

### **Faculty and Staff**

- 1) Board-certified radiation oncologists
- 2) Medical residents
- 3) Medical physicists
- 4) Medical physics residents
- 5) Computer programmers
- 6) Certified medical dosimetrists
- 7) Medical dosimetry students
- 8) Registered radiation therapists
- 9) Radiation therapy students
- 10) Certified oncology nurses

- 11) Administrative assistants
- 12) Laboratory, computer science and clinical trials researchers
- 13) Process improvement faculty and staff
- 14) Undergraduate, graduate, postdoctoral and medical student researchers

## **How to Apply**

Application forms can be downloaded from the UNC Department of Radiation Oncology Web site ([med.unc.edu/radonc/pro/education](http://med.unc.edu/radonc/pro/education)) and are also available upon request from the program director. Completed applications must be submitted no later than January 1 preceding August (Fall) enrollment. Specific information required for a complete application includes:

- 1) Official high school transcript (if less than 5 years since graduation)
- 2) Official higher education transcripts (technical schools/community colleges/colleges/universities, etc.)
- 3) Official radiologic technology program transcript
- 4) Three written references using the UNC Hospitals Radiation Therapy Program reference forms
- 5) Additional information as requested by program admissions

A personal interview and visit to the UNC Department of Radiation Oncology is a required part of the admissions process. March 1 is the target date for admissions decisions.

A maximum of 7 students may be admitted to the program each year. This may vary as program needs change.

## **Tuition and Fees**

There is no application fee. The computer/laboratory fee of \$1,500 is to be paid during orientation. There are also costs for books (approximately \$300), a lab coat, and other school supplies. Housing, health insurance, an official drug test, travel to and from external clinical settings, and parking are the responsibility of the student (JRCERT Standard 1). The program does not participate in Title IV financial aid (JRCERT Standard 2.4). Private loans may be secured by personal banks. The program director will also provide any necessary documentation to defer student loans (JRCERT Standard 2).

## **Transfer Students/Credits**

The UNC Hospitals Radiation Therapy Program does not accept transfer students or transfer credits. It is up to the program the student is applying for as to whether credits received during this program will be accepted at another program (JRCERT Standard 1.9).

## **Program Physical Requirements**

1. The physical activity of this position requires the student to be able to: climb, push, talk, stand, hear, walk, reach, grasp, kneel, feel, balance, pull, stoop, lift, use fingers, crawl, crouch, and perform repetitive motion.

2. The physical requirements of this position require the student be able to perform heavy work involving the exertion of up to 100 lbs. of force occasionally and/or 50 lbs. of force frequently.
3. The visual requirements, including color, depth perception, and field of vision are that the student's visual acuity is required to determine the accuracy, neatness, and thoroughness of the work assigned or to make general observations.
4. The conditions to which the student will be subject in this position include, but are not limited to: inside environmental conditions.
5. Hazards include physical conditions such as proximity to moving parts, electrical current, etc.
6. The student may be exposed to infectious diseases.
7. The student may have to interact with prisoners or mentally-challenged patients.

# January 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	<b>3</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>4</b> Class	<b>5</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>6</b> Class	<b>7</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>8</b>
<b>9</b>	<b>10</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>11</b> Class	<b>12</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>13</b> Class	<b>14</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>15</b>
<b>16</b>	<b>17</b> MLK DAY	<b>18</b> Class Day	<b>19</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>20</b> Class Day	<b>21</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>22</b>
<b>23</b>	<b>24</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>25</b> Class Day	<b>26</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>27</b> Class Day	<b>28</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan	<b>29</b>
<b>30</b>	<b>31</b> Clinic Duke: Ryan CT Sim: Ireland Versa 1: Laura Versa 2: Ethan					

# February 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	<b>31</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>1</b> Class	<b>2</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>3</b> Class	<b>4</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	
<b>6</b>	<b>7</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>8</b> Class Day	<b>9</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>10</b> Class Day	<b>11</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>12</b>
<b>13</b>	<b>14</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>15</b> Class Day	<b>16</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>17</b> Class Day	<b>18</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>19</b>
<b>20</b>	<b>21</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>22</b> Class Day	<b>23</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>24</b> Class Day	<b>25</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland	<b>26</b>
<b>27</b>	<b>28</b> Duke: Laura Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland					

# March 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	1 Class	2 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	3	4 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	5 Spring Break
6 Spring Break	7 Spring Break	8 Spring Break	9 Spring Break	10 Spring Break	11 Spring Break	12 Spring Break
13 Spring Break	14 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	15 Class	16 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	17 Class	18 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	19
20	21 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	22 Class Day	23 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	24 Class Day	25 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	26
27	28 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	29 Class Day	30 Duke: Ireland CT/Sim: Ryan Versa 1: Ethan Versa 2: Laura	31 Last Day of Class 2 <sup>nd</sup> Semester	April 1 Clinical Make Up Day	April 2

# April 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
3	4 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	5	6 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	7 Class Day	8 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	9
10	11 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	12 Class Day	13 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	14 Class Day	15 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	16
17	18 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	19 Class Day	20 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	21 Class Day	22 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	23
24	25 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	26 Class Day	27 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	28 Class Day	29 Duke: Ethan CT Sim: Laura Versa 1: Ireland Versa 2: Ryan	30

# May 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	3 Class Day	4 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	5 Class Day	6 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	7
8	9 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	10 Class Day	11 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	12 Class Day	13 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	14
15	16 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	17 Class Day	18 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	19 Class Day	20 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	21
22	23 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	24 Class Day	25 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	26 Class Day	27 Ct Sim: Ethan Versa 1: Ryan Versa 2: Ireland Tomo: Laura	28
29	30 Memorial Day HOLIDAY	31 Class Day				

# June 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	<b>May 30</b> Holiday	<b>May 31</b> Class Day	<b>1</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>2</b> Class Day	<b>3</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>4</b>
<b>5</b>	<b>6</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>7</b> Class Day	<b>8</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>9</b> Class Day	<b>10</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>11</b>
<b>12</b>	<b>13</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>14</b> Class Day	<b>15</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>16</b> Tomo: Ethan Ct Sim: Ireland Versa 1: Ryan Versa 2: Laura	<b>17</b> Graduation	<b>18</b>
<b>19</b>	<b>20</b> Clinical Makeup days, any final incomplete comps	<b>21</b> Clinical Makeup days, any final incomplete comps	<b>22</b> Clinical Makeup days, any final incomplete comps	<b>23</b> Clinical Makeup days, any final incomplete comps	<b>24</b> Clinical Makeup days, any final incomplete comps	<b>25</b>
<b>26</b>	<b>27</b> Clinical Makeup days, any final incomplete comps	<b>28</b> Clinical Makeup days, any final incomplete comps				

# July 2021

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1 Class: Orientation	2 Class: Orientation	3
4	5 HOLIDAY	6 Class Day	7 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	8 Class Day	9 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	10
11	12 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	13 Class Day	14 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	15 Class Day	16 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	17
18	19 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	20 Class Day	21 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	22 Class Day	23 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	24
25	26 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	27 Class Day	28 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	29 Class Day	30 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	31

# August 2021

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	3 Class Day	4 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	5 Class Day	6 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	7
8	9 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	10 Class Day	11 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	12 Class Day	13 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	14
15	16 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	17 Class Day	18 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	19 Class Day	20 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	21
22	23 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	24 Class Day	25 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	26 Class Day	27 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	28
29	30 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	31 Class Day				

# September 2021

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1 Clinic CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	2 Class Day	3 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	
5	6 Labor Day HOLIDAY	7 Class Day	8 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	9 Class Day	10 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	11
12	13 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	14 Class Day	15 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	16 Class Day	17 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	18
19	20 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	21 Class Day	22 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	23 Class Day	24 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	25
26	27 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	28 Class Day	29 CT/Sim: Laura Versa1: Ethan Tomo: Ireland Versa 2: Ryan	30 Class Day		

# October 2021

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	
3	4 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	5 Class Day	6 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	7 Fall Break	8 Fall Break	9
10	11 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	12 Class Day	13 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	14 Class Day	15 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	16
17	18 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	19 Class Day	20 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	21 Class Day	22 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	23
24	25 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	26 Class Day	27 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	28 Class Day	29 CT/Sim: Ryan Versa 1: Laura Tomo: Ethan Versa 2: Ireland	30

# November 2021

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Oct 31	1 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	2 Class Day	3 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	4 Class Day	5 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	
7	8 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	9 Class Day	10 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	11 Class Day	12 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	13
14	15 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	16 Class Day	17 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	18 Class Day	19 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	20
21	22 Thanksgiving	23 Thanksgiving	24 Thanksgiving	25 Thanksgiving	26 Thanksgiving	27
28	29 CT/Sim: Ireland Versa 1: Ryan Tomo: Laura Versa 2: Ethan	30 Class Day				

# December 2021

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	2	3 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	4
5	6 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	7 Class Day	8 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	9 Class Day	10 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	11
12	13 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	14 Class Day	15 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	16 LAST Class Day	17 CT/Sim: Ethan Versa1: Ireland Tomo: Ryan Versa 2: Laura	18
19	20 Winter Break	21 Winter Break	22 Winter Break	23 Winter Break	24 Winter Break	25
26	27 Winter Break	28 Winter Break	29 Winter Break	30 Winter Break	31 Winter Break	Jan 1, 2022

University of North Carolina (UNC) Hospitals  
 Radiation Therapy Program (JRCERT 0906)  
 Assessment Plan: Analysis and Actions  
 Fall (1<sup>st</sup> semester) 2021 – Summer (3<sup>rd</sup> semester) 2022

Completed July, 2021

**Mission Statement: The UNC Hospitals Radiation Therapy Program will prepare competent, educated, and professional entry-level radiation therapists who will participate in scholarly activity and enhance overall patient care.**

**Goal 1: Students will be clinically competent.**

Outcome	Measures	Benchmarks	Assessment Schedule	Responsible Person(s)	Results	Metrics	Action Plans
Students will demonstrate acquisition of correct CT-Simulation skills.	1) Overall Radiation Therapy Clinical Evaluation Form: specifically overall clinical adaptability and clinical performance on the CT-Simulation rotation) (questions 1 &4)	1) 100% of students will have at least a 3 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters; and to demonstrate continuous improvement, average a 4 on a 5 point scale in the 3 <sup>rd</sup> semester	1) Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semesters; Summative 3 <sup>rd</sup> semester	Program Director (reported annually to the advisory committee)	2020: 4.9 2019: 4.8 2018: 4.8 2017: 4.7 2016: 4.7 2015: 4.6 2014: 4.5	100% of students 2014-2020 met benchmark goals. Average scores are increasing over the past 6 years. There were a total of 21 students over the past seven years; each student averages 280 total contact hours in the CT-Simulation clinical rotations.	Our clinical CT-Simulation clinical rotation scores continue to improve, even as set-ups continuously become more complicated. The program will continue to assess improved overall student conceptualization of clinical process and knowledge theory through faculty and staff feedback loops.
	2) Graduate survey (IIF)	2) 100% of students will have at least a 4 on a 5 point scale	Annually	Program Director reported annually to the advisory committee	2020: 4.9 2019: 4.9 2018: 4.9 2017: 4.9 2016: 4.9 2015: 4.8 2014: 4.7	100% of students 2014-2020 met benchmark goal. Average scores increasing over the past 6 years.	From 2014-2020 we received 15/25 graduate surveys. We have designed, implemented, and evaluated CT-Simulation didactic laboratory sessions. The program will assess if this course needs to expand to include emerging technology.

	3) Employer survey (IIG,H)	3) 100% of students will have at least a 4 on a 5 point scale	Annually	Program Director Reported to Advisory Committee	2020: 4.7 2019: 4.65 2018: 4.6 2017: 4.6 2016: 4.6 2015: 4.5	100% of students 2015-2020 met benchmark goal. Average scores increasing over the past 5 years.	From 2011-2020 we received 17/20 employer surveys. There were no explicit comments from employers given on CT-Sim areas that needed improvement. The program will continue to monitor.
	4) Student Program Exit Surveys	4)100% of students will pass the required CT-Simulation clinical competencies and will not exceed more than two failed competencies.	Annually	Program Director Reported to Advisory Committee	2020: 100% 2019: 100% 2018: 100% 2017: 100% 2016: 100% 2015: 100%	100% of students 2014-2020 met benchmark goal. Average scores increasing over the past 5 years.	Since 2015 we have evaluated 24/24 student program exit assessment surveys. From the 2016 survey, we designed and implemented additional CT laboratory sessions for our students. This is taught as part of the RTT 500 (Foundations of Radiotherapy) course. The program will continue to monitor.
Students will evidence competency in treatment delivery skills	1) Overall Clinical Treatment Competency Evaluation Form (8,10,11,12,15,18,19 ,21,22): reproduces designed set-up, implements correct position, alignment, and wedges; rechecks set-up and downloads correct fields; implements treatment and visually monitors patient and computer; records and documents all information;	1) 100% of students will score a mean of at least a 4 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters; and to demonstrate continuous quality improvement at least a 4.5 on a 5 point scale in the 3 <sup>rd</sup> semester	1) Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semesters Summative : 3 <sup>rd</sup> semester	Program Director (reported annually to the advisory committee)	2020: 4.95 2019: 4.9 2018: 4.9 2017: 4.8 2016: 4.8 2015:4.8	100% of students 2015-2020 met benchmark goal. Average scores have increased over the past 5 years. Moreover, students are demonstrating increased knowledge, skills, and abilities as he/she progresses through the program.	The program will continue to monitor emerging technology and that students have adequate knowledge to perform competency level treatments. New objectives for emerging tomotherapy and cyberknife rotations are now in the curriculum; these will

	evaluates that treatment was completed correctly.						continue to be monitored. Our students have 100% completed all required program clinical competencies.
	2) Graduate survey (IC,D)	2) 100% of students will have at least a 4 on a 5 point scale	Annually	Program Director reported annually to the advisory committee	2020: 4.9 2019:4.9 2018:4.9 2017:4.9 2016:4.9 2015: 4.9	100% of students 2015-2020 met benchmark goal. Average scores have consistently remained high over the past 5 years.	From 2015-2020we received 19/24 graduate surveys. The students were satisfied with their overall competency based treatment delivery skills
	3) Employer survey (IC,D)	3) At least a 4 on a 5 point scale	Annually	Program Director reported	2020:4.9 2019:4.9 2018:4.9 2017:4.9 2016: 4.9 2015: 4.9	100% of students 2015-2020 met benchmark goal. Average scores iconsistently remaining high over the past 5 years.	From 2015-2020 we received 19/24 employer surveys. Employers were satisfied with our graduates overall treatment delivery skills.
	4) Student program exit surveys.	4)At the completion of the academic year, upon graduation 100% of students will record all required program clinical competencies and will not exceed more than two failed competencies.			2020: 100% 2019: 100% 2018: 100% 2017: 100% 2016: 100% 2015: 100%	100% of students 2015-2020 met benchmark goal.	Since 2015 we have evaluated 24/24 student program exit assessment surveys. Due to the surveys, we designed, implemented, and evaluated additional competency based clinical rotations in tomotherapy, cyberknife, and medical dosimetry treatment planning (UNC inhouse designed on-line learning modules). The program will continue to monitor.

**Goal 2: Students will demonstrate effective communication skills.**

Outcome	Measures	Benchmarks	Assessment Schedule	Responsible Person(s)	Results	Metrics	Action Plans
Students will effectively communication skills with patients, therapists, faculty and staff.	1) Weekly Clinical Evaluation (III1) Professional Behavioral Skills Evaluation Component (affective domain)	1) At least a 3 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters, and a 4 on a 5 point scale in the 3 <sup>rd</sup> semester	1) Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semesters Summative: 3 <sup>rd</sup> semester	Program Director (reported annually to the advisory committee)	2020: 4.9 2019: 4.8 2018: 4.8 2017: 4.7 2016: 4.7 2015: 4.7	100% of students 2015-2020 met our <u>two</u> benchmark goals. Average scores increasing over the past 5 years.	We will continue to urge clinical instructors and faculty to work extra with our students on treatment and class exercises. We will continue to evaluate our interprofessional education class first, second, and third semesters.
	2) Treatment Competency Evaluation Patient Communication Section(3,4,5)	2) At least a 4 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters, and a 5 on a 5 point scale in the 3 <sup>rd</sup> semester		Program Director (reported annually to the advisory committee)	2020: 4.9 2019: 4.9 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8		
	3) Graduate survey (IIIK)	3) At least a 4 on a 5 point scale	Annually	Program Director (reported annually to the advisory committee)	2020: 4.9 2019: 4.9 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8	100% of our alumni met this benchmark from 2015-2020. Our graduates feel very comfortable in their communication skills.	We will continue to evaluate the interprofessional class. The RTT Program's start and graduation dates were changed to coincide with the UNC Medical Physics and Residencies programs, in 2015.
	4) Employer survey (IIIK)	4) At least a 4 on a 5 point scale	Annually	Program Director (reported annually to the advisory committee)	2020: 4.9 2019: 4.9 2018: 4.8	100% of our graduates met this benchmark goal from 2015-2020 with average scores	Our employer surveys indicate strong communication skills. The program will

					2017: 4.8 2016: 4.8 2015: 4.7	increasing over the past 5 years.	need to continually assess how technology effects communication processes.
Students will write at a proficient level by graduation.	1) UNC Research Paper Grading Rubric	1) That each student (100%) will have submitted a research paper for professional publication by the time of his/her graduation.	Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semester Summative: 3 <sup>rd</sup> semester	Program Director  Reported annually to the advisory committee	2020: 100% 2019: 100% 2018: 100% 2017: 100% 2016: 100% 2015: 100%	100% of students 2015- 2020 met benchmark goal for submitting his/her research paper for professional publication. Average scores have been continuous over the past 5 years.	Each student is required to design and write a research paper during the academic year. The grading rubric requires submission to professional publication in order to receive the grade of 'A'. During the past five years, our radiation therapy program has produced 11/24 students whose papers have been published in professional journals. 100% of our graduating students have gone thru the process of submitting their research papers for professional publication. Plan is to continue assessing areas to create knowledge and link to the publications.

**Goal 3: Students will demonstrate critical thinking skills.**

Outcome	Measures	Benchmarks	Assessment Schedule	Responsible Person(s)	Results	Metrics	Action Plans
Students apply didactic concepts and information into the clinical setting.	1) Weekly Clinical Evaluation, application of knowledge section	1) Students will average at least a 3 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters, and a 4 on a 5 point scale in the 3 <sup>rd</sup> semester	Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semesters Summative: 3 <sup>rd</sup> semester	Program Director (reported annually to the advisory committee)	2020: 4.9 2019: 4.8 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8	100% of our students met this goal from 2015 until 2020. The program continues to maintain a high standard in this area.	With continuous changing technologies and treatments, the program will continue to design curriculum to change with complex clinical changes. This assessment will come from our communities of interest.
	Average of actual scores of all clinical evaluations	2) At least a 4 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters, and a 4.5 on a 5 scale in the 3 <sup>rd</sup> semester	Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semesters, Summative: 3 <sup>rd</sup> semesters	Program Director reported annually to the advisory committee.	2020: 4.9 2019: 4.8 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8	100% of our students met this goal from 2015 until 2020.	Our program will continue to monitor knowledge theory with application theory. A program research interest is the educational theory of this style of knowledge transformation.
Students will conceptualize current patient safety radiation therapy Lean A3 engineering principles	Design, implementation and evaluation of an individual A3 radiation therapy safety problem.	To meet minimal patient safety engineering standards when completing a radiation therapy safety problem and have this accepted for submission to the UNC Departmental Radiation Therapy Human Factors Engineering Division	Completed by graduation	Program Director Reported annually to the advisory committee.	2020: 100% 2019: 100% 2018: 100% 2017: 100% 2016: 100% 2015: 100%	100% of our students have met this goal since its development and implementation with the Class of 2018. Moreover, we have two students submit their A3 to the ASTRO 2016 meeting for professional abstract submission. Our students continue to be involved with Lean Safety concepts and two students have published.	Patient safety standards and quantitative methodologies are an emerging concept in radiation therapy clinical practice. Our program should continue to develop leaders in emerging patient safety processes. Coupled with ASTRO APEx accreditation requirements the program will continue to expand these concepts into the curriculum.

**Goal 4: Students will grow and develop professionally**

Outcome	Measures	Benchmarks	Assessment Schedule	Responsible Person(s)	Results	Metrics	Action Plans
Students will demonstrate professional behaviors.	1) Weekly Clinical Evaluation (III1,2) 2) Overall Clinical Evaluation (2,3)	1,2) At least a 4 on a 5 point scale in the 1 <sup>st</sup> and 2 <sup>nd</sup> semesters, and a 5 on a 5 point scale in the 3 <sup>rd</sup> semester	Formative: 1 <sup>st</sup> and 2 <sup>nd</sup> semesters Summative: 3 <sup>rd</sup> semester	Program Director (reported annually to the advisory committee)	2020:4.95 2019: 4.9 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8	100% of our graduates met both measures during the past five years.	The issue of health care professional behavior continues to be challenging in a changing social culture. Our students come into the program with various perceptions of professional behavior. During orientation midsemester and post semester conferences, the program director utilizes the outcome metrics to reinforce behavior patterns. The program will continue to monitor and develop methods to increase professional behavior.
	3) Graduate survey (III L)	3) At least a 4 on a 5 point scale	Annually	Program Director reported annually to the advisory committee.	2020: 4.9 2019: 4.9 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8	100% of our graduates met this measure during the past five years.	Our program will continue to integrate professional behavior, dress and appearance as a correlation with earning respect from patients and co-workers.
			Annually		2020: 4.9		

	4) Employer survey (IIIL)	4) At least a 4 on a 5 point scale		Annually by program director to the advisory committee	2019: 4.8 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.7	100% of our graduates met this measure during the past five years.	This demonstrates success to our communities of interest.
Students will participate in continuing education.	1) Graduate survey (IVA,B,C,D)	1) At least a 4 on a 5 point scale	Annually	Annually by program director to the advisory committee	2020: 4.9 2019: 4.9 2018: 4.9 2017: 4.9 2016: 4.9 2015: 4.9	100% of our graduates met this measure during the past five years.	The program will continue assess new academic theories concerning professional education and development. This is an emerging higher education academic field.
	2) Employer survey (IIIO)	2) At least a 4 on a 5 point scale	Annually	Annually by program director to the advisory committee	2020: 4.9 2019: 4.8 2018: 4.8 2017: 4.8 2016: 4.8 2015: 4.8	100% of our graduates met this measure during the past five years.	Our students are taught that creating knowledge and educational inquiry are strong components of being a professional. The program will continue to develop academic theory models to emphasize professional development.