Physics for Residents in Radiation Therapy
or
Practical Radiotherapy Physics, MBP 9672B
London Regional Cancer Program
London Health Sciences Centre
January – August 2019

Primary Resource:
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Secondary Resource:
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Teaching Assistant:
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Evaluation:
Assignments: 20% (5% per day penalty for late assignments)
Midterm: 10% oral; 15% written
Final Examination: 55% (based on all sections)

RO only: Passing Grade on Final Exam: 65%
RO only: Passing Grade on Amalgamated Mark: 70%

Location and Time:
Lectures are held at the London Regional Cancer Program at Victoria Hospital, room A1-155 on Tuesdays from 1 to 2:30 pm. There will be two labs that may run in the early evening. We will find a mutually agreeable time to schedule those. The mini labs will be accommodated within the regular class time. Note that this course runs once a week only, January through August, to accommodate the schedules of the Radiation Oncology residents, who also attend these lectures. Please check with the instructor in mid-December to confirm the first lecture date.

Office Hours:
Due to Dr. Surry’s clinical responsibilities, please request a meeting in person or by email.

Course Description:
This course has been a cornerstone in the physics curriculum of the Radiation Oncology and Medical Physics Residencies for many years. It was opened to the MBP curriculum as part of the CAMPEP program in 2012. For the residents, this course provides didactic support to clinical experience. For graduate students, it provides an introduction to how radiation physics is used in a clinical setting for cancer treatment and cancer cure. This course is not available to undergraduate students.
Course Outline (approximate number of classes as indicated):

1. Introduction (1/2)
2. The Basics (1/2)
   a. What is radiation?
   b. Fundamental particles and the atom
   c. Mass and energy relationship
   d. Structure of matter
   e. Waves and photons
3. External Beam Radiation Therapy: Focus on The Linac (~14)
   a. Overview of the Basic Components of a Linac
   b. Room Layout and Patient Set-up
   c. Mini Lab #1: field trip to see a linac
   d. Electron Gun and Accelerating Waveguide (1)
      i. Operational theory of waveguides
      ii. Bending magnet systems
   e. Photon Beam Production (2)
      i. Electron interactions with matter, including Bremsstrahlung
      ii. Target design
      iii. Photon beam characteristics before modification
      iv. The flattening filter and beam hardening
   f. Photon Beam Delivery (3)
      i. Dose Deposition
         1. Photon interactions in matter
            a. Compton
            b. Pair Production
            c. Photoelectric Effect
      ii. Collimation
         1. Penumbra
         2. Cross beam dose curves
         3. Beam Shaping
      iii. Dose Deposition continued...
         1. Dose deposition by electrons
         2. KERMA, exposure and dose
         3. Depth dose curves
         4. Inverse square law
      iv. Mini Lab #2: exploring dose deposition using planning software
   g. Beam Monitoring (2)
      i. MU chambers
      ii. Other radiation and dose monitoring devices
         1. Farmer chambers
         2. Geiger counters
         3. Diodes
         4. TLD’s
h. Photon Beam Dosimetry Lab (1)
i. Introduction to CPQR (1)
   i. includes an in-class group assignment
j. Bunker Design and Radiation Safety in an RT Context (1)
   i. Primary and secondary barriers
   ii. Room design considerations
   iii. Monitors and signage
   iv. Licenses and dose limits
   v. Field trip to a bunker!
k. Linac Commissioning and QA (1)
   i. Beam data and reference conditions
   ii. Overview of QA Tests and their frequency
l. Treatment Field Imaging (1)
   i. Portal imaging, including EPID
   ii. 2D kV imaging
   iii. 3D kV imaging
   iv. Mini Lab #3: image matching with CBCT

4. Imaging for Radiation Therapy (2)
a. CT
   i. x-ray production
   ii. CT scanners
   iii. CT simulators
b. MRI
c. PET
d. Ultrasound
e. Mini Lab #4: image fusion with CT Sim & other modalities

5. Dose Calculation and Beam Modelling (3)
a. Dosimetric Parameters (2)
   i. PDD, TAR, TPR etc...
b. Contour Corrections (1/2)
   i. Photon beams
   ii. Electron beams
c. Inhomogeneity Corrections (1/2)
   i. Photon beams
   ii. Electron beams
d. Modern Dose Modelling Algorithms (1)
   i. Source Data
   ii. Algorithms used by Philips’ Pinnacle and by Varian’s Eclipse
   iii. Monte Carlo Modelling – the future?
e. Treatment Planning Lab (1)

6. Electron Beam Dose Delivery (2)
a. Electron dose deposition (quick review of 3.f.i.2)
b. Depth dose curves
c. Cross beam dose curves, including penumbra
d. Field size limitations

e. Mini Lab #5: electron beam dose deposition modelling

7. Brachytherapy (3)
   a. Clinical Considerations
   b. Clinical Machines
   c. Radioactivity Physics (1)
      i. Isotopes
      ii. Activity and Half Life
      iii. Specific Activity
      iv. Types of Decay (alpha, beta, e\textsuperscript{-} capture; daughter products)
   d. Air Kerma Strength and Apparent Activity
   e. Dose Calculation (TG-46)
   f. Mini Lab #6: brachytherapy dose planning

8. Other Treatment Machines and Special Techniques (1-2)
   a. Co-60 Teletherapy Machines
   b. Orthovoltage Machines
   c. Tomotherapy
   d. The Cyberknife and The Gamma Knife
   e. Cyclotrons and Synchrotrons
   f. Neutron and Proton Therapy
   g. Total Body Irradiation (TBI)
   h. Total Skin Electron Irradiation (TSEI)
   i. Stereotactic Radiation Therapy and Radiosurgery

9. Radiation Safety and the Role of the Physicist (1)

**Additional Information and Statements of Policy**

**Attendance Policy**

All classes, laboratories, and tutorials are mandatory, unless otherwise stated. Any student who, in the opinion of the course co-ordinator is absent too frequently from class or laboratory periods in any course, will receive a failing grade after due warning has been given in writing from the course co-ordinator and Graduate Chair.

**Cheating and Plagiarism Policy**

Students are encouraged to work together, but each student must take total responsibility for his/her submitted work. Students must write their laboratory reports and final projects in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by
academic penalties which might include expulsion from the program. If a student is caught cheating, there will be no second warning. All written reports and projects may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All reports will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com).

See the School of Graduate and Postdoctoral Studies Scholastic Offence Policy http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

Use of Electronic Devices Policy

No electronic devices (e.g., cell phones, MP3 players) may be used during lectures or examinations. The use of non-programmable calculators is permitted during examinations; programmable calculators are prohibited during examinations.

OWL Internet/Bulletin Board Policy

It is the student’s responsibility to read the course website posted on Western’s on-line learning management system, OWL (https://owl.uwo.ca/portal). This includes the course bulletin board and all information and/or assignments posted about the course. If the student fails to act on information that has been posted on the course site and does so without a legitimate explanation (i.e., those covered under the illness/compassionate form), then there are NO grounds for an appeal.

Request for Assignments Extensions

Students are advised to inform the course co-ordinator as soon as possible regarding an extension for assignment submissions due to medical reasons or other compassionate reasons. Extensions will only be granted by the course coordinators at their discretion.

Absence Due to Medical Illness

Students must familiarize themselves with the Policy on Accommodation for Medical Illness: https://studentservices.uwo.ca/secure/index.cfm

If you are unable to meet a course requirement due to illness or other serious or compassionate circumstances, you must provide valid medical or other supporting documentation to the course co-ordinator immediately. It is the student's responsibility to make alternative arrangements with the co-ordinator to complete missing course requirements.

A student requiring academic accommodation due to illness, should use the Student Medical Certificate:
when visiting an off-campus medical facility or request a Record's Release Form for visits to Student Health Services.

The form is available at:
http://www.health.uwo.ca/services/students/policies.html

The release form will allow the course co-ordinator to confirm with Student Health Services that a student’s absence from regular attendance or inability to meet scheduled course commitments is due to medical reasons. The nature of the illness will not be divulged by Student Health Services.

**Graduate Students’ Mental Health and Physical Wellness**

As part of a successful graduate student experience at Western, students are encouraged to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western’s Campus Recreation Centre:
http://www.uwo.ca/campus_life/athletics.html

All facets of extracurricular campus life in which graduate students can participate are available on this URL:
http://www.uwo.ca/campus_life/arts_culture.html

Information regarding health and wellness-related services available to students may be found at http://www.health.uwo.ca. Students seeking help regarding mental health concerns are advised to speak to someone in whom they feel comfortable confiding, such as their graduate supervisor, their program director (Graduate Chair), or other relevant administrators in their unit. Campus mental health resources may be found at:
http://www.health.uwo.ca/mental_health/resources.html

**Accessibility to the Course and Course Materials**

Please contact the course co-ordinator if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.