London Health Sciences Centre

Physics for Residents in Radiation Therapy
or
Practical Radiotherapy Physics, MBP 9672B

London Regional Cancer Program
London Health Sciences Centre
September 2014 – April 2015

Primary Resource:
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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)

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

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 (1/3)
    b. Room Layout and Patient Set-up (1/3)
    c. Field Trip to see a Linac! (1/3)
    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
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. 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!
j. Linac Commissioning and QA (1)
    i. Beam data and reference conditions
    ii. Overview of QA Tests and their frequency
k. Treatment Field Imaging (1)
    i. Portal imaging, including EPID
    ii. 2D kV imaging
    iii. 3D kV imaging
    iv. Field trip to see a CBCT treatment!

4. Imaging for Radiation Therapy (2)
    a. CT (1)
        i. x-ray production

ii. CT scanners
iii. CT simulators

b. MRI (1/3)
c. PET (1/3)
d. Ultrasound (1/3)

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

7. Brachytherapy (3)
    a. Clinical Considerations (1/3)
    b. Clinical Machines (1/3)
    c. Field Trip to the OR! (1/3)
    d. Radioactivity Physics (1)
        i. Isotopes
        ii. Activity and Half Life
        iii. Specific Activity
        iv. Types of Decay (alpha, beta, e^- capture; daughter products)
    e. Air Kerma Strength and Apparent Activity (1/2)
    f. Dose Calculation (TG-46) (1/2)

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)

Tentative Schedule

Date	Lecture	Instructor (tentative)	Assignments due date (tentative)
9-Sep	Intro Math	RB	
16-Sep	Basic Radiation	RB	
23-Sep	Introduction to Linac	RB	
30-Sep	Electron Gun Waveguide	RB	Assignment 1
7-Oct	X rays in Target	RB	
14-Oct	Flattening filter	RB	
21-Oct	Collimation Penumbra	RB	
28-Oct	Dose Deposition	RB	
4-Nov	Practical Dosimetry	RB	Assignment 2
18-Nov	Electrons	SK	
25-Nov	Bunker design Dosimetry Lab after class at 6 pm	SS/ IX and MM	
2-Dec	Commissioning	HF	
9-Dec	OBI	HF	Assignment 3
16-Dec	X-ray Generation CT scanners	SG	
6-Jan	Imaging Modalities	GH	
13-Jan	**Midterm**		
20-Jan	Dosimetric Parameters	HF	
27-Jan	MU Calculations	CL	
3-Feb	Contour Corrections	CL	
10-Feb	Inhomogeneity Corrections	GH	
17-Feb	Treatment Planning System	JC	
24-Feb	Contour DVH planning	JC	
3-Mar	Treatment Planning Lab	IX and AE	
10-Mar	Other Treatment machines	SY	
17-Mar	Brachytherapy Background	DH	Assignment 4
24-Mar	Radioisotopes and Radioactive decay	GH	
31-Mar	Special Procedures	SY	
7-Apr	Radiation Safety	SS	Assignment 5
April 14-21	**EXAM**		

Suggested Reference List

The Physics of Radiation Therapy, 3rd Edition
FM Khan. Lippincott Williams & Wilkins, 2003.

Radiation Oncology Physics: A Handbook for Teachers and Students
EB Podgorsak. Published by the IAEA, 2005.
http://www-pub.iaea.org/mtcd/publications/pdf/pub1196_web.pdf

The Modern Technology of Radiation Oncology
J Van Dyk. Medical Physics Publishing, 1999.

The Essential Physics of Medical Imaging, 2nd Edition
JT Bushberg et al. Lippincott Williams & Wilkins, 2002.

The Physics of Radiology, 4th Edition
HE Johns & JR Cunningham. Charles C Thomas, 1983.

Radiobiology for the Radiologist, 7th Edition
E Hall & A Giaccia. Lippincott Williams & Wilkins, June 2011.

Basic Clinical Radiobiology, 4th Edition
M Joiner & A van der Kogel. Hodder Arnold, 2009.
(3rd Edition edited by G Steel, 2002)

AAPM Task Group (TG) Reports:
(http://www.aapm.org/pubs/reports/default.asp)
TG-25: Electron Beam Dosimetry
TG-34: Pacemaker Dose Limits
TG-36: Fetal Dose Limits
TG-40: QA Protocols
TG-43: Brachytherapy Dose Calculations
TG-45: Linac Commissioning and QA
TG-51: High Energy Dosimetry
TG-56: Brachytherapy Practice
TG-65: Tissue Inhomogeneity Corrections for MV
TG-66: CT-Sim QA

Other Reports (ask instructor for copies if you're interested)
ICRU-50: Prescribing, Recording and Reporting Photon Beam Therapy (1993)
ICRU-51: Quantities and Units in Radiation Protection Dosimetry (1993)
ICRP-60: Recommendations of the International Commission on Radiological Protection (1990)