Forster, Sara

From: Durbin, Christopher M [Christopher.Durbin@stlukes-stl.com]
Sent: Thursday, April 05, 2012 10:07 AM
To: Forster, Sara
Subject: Mail Control Number: 576920
Attachments: Classroom Info.pdf

Sara,

This is in regards to the license amendment adding Dr. Bhatt to our license as an authorized user. You had requested further information regarding his classroom hours. I asked Dr. Bhatt what course listings or course descriptions he could provide. I have attached, in PDF format the information he provided. The first page provides information on the formal class (it is part of the graduate program in medical physics). The other classroom hours are not in the form of classes in the sense that the residents do not sign up for a certain course which has a course number, etc. The subject matter covered is included in the PDF attachment. I should also mention that the program of which he was enrolled conforms to the Accreditation Council for Graduate Medical Education (ACGME) Radiation Oncology Program requirements. Please let me know if additional information is required.

Thanks,

Christopher Durbin, Ph.D.
Radiation Safety Officer

Graduate Program
–Current Students

Course Descriptions

One can see a typical course sequence by clicking here

Fall Semester

MP 463, ***q+** Radioisotopes in Med & Biol (2-3cr)
MP 471, Special Topics (Fall) (1-3cr)
MP 501, ***q+** Radiological Physics, Dosimetry (3cr)
MP 547, Biomedical Optics (3cr)
MP 567, ***qi+** Physics of Diagnostic Radiology (3cr)
MP 571, Adv. External Beam Rad Oncology (3cr)
MP 573 Medical Image Science: Mathematical and Conceptual Foundations (3 cr)
MP 577 Principles of X-Ray Computed Tomography
MP 699, Independent Reading
MP 679, Radiation Physics Metrology
MP 710, Adv. Magnetic Resonance Imaging (2cr)
MP 661,662,664,665,666, * Rad Labs
MP 900, Journal Club/Seminar (Fall Series)
MP 990, Graduate Research (Fall)

Spring Semester

MP 265, Intro to Med Physics (2cr)
MP 401 , Intermed Physics for Med, Biol (3cr)
MP 410, * Radiobiology (Even yrs, 2002, 2004, etc) (2cr)
MP 471, Special Topics (Spring) (1-3cr)
MP 530, Medical Imaging Systems (3cr)
MP 559, Patient Safety and Error Reduction in Health Care (2cr)
MP 566, ***q** Physics of Radiotherapy (4cr)
MP 568, +Magnetic Resonance Imaging (3cr)
MP 569, ***q+** Health Physics (3-4cr)
MP 570, Adv. Brachytherapy Physics (Odd yrs, 2003, 2005, etc) (3cr)
MP 574 Imaging in Medicine: Applications (3 cr)
MP 575, +Diagnostic Ultrasound Physics (3cr)
MP 619 Microscopy of Life (2cr)
MP 662,663,664,665,666, * Rad Labs
MP 707, Digital X-Ray Imaging (2cr)
MP 900, Journal Club/Seminar (Spring Series)
MP 911, Radiological Facts for Physicians
MP 990, Graduate Research (Spring)

**Required for MS Degree in General Medical Physics*
+Required for MS Degree in the Imaging Track
***q** Course material required on the General MP Qualifier*
***I** Course material required on the Image Track qualifier*
*** Offered each semester and during the summer*

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265 Introduction to Medical Physics.; 2 cr. (Cross listed with Physics 265) Primarily for premeds and other students in the medical and biological sciences. Applications of physics to medicine and medical instrumentation. Topics: biomechanics, sound and hearing, pressure and motion of fluids, heat and temperature, electricity and magnetism in the body, optics and the eye, biological effects of light, use of ionizing radiation in diagnosis and therapy, radiation safety, medical instrumentation. Two lectures with demonstrations per week P: Year of college-level introductory physics.

401 Intermediate Physics for Medicine and Biology. II; 3 cr. (Cross listed with Biomed. Eng. 401) Biomedical applications of physics including, e.g., solute exchange involving capillaries and glomeruli, differences in ionic concentrations and electric potentials across cell membranes, the electrodynamics of nerve impulse transmission (including the Hodgkin-Huxley model), and the atomic and molecular physics of radiative heat loss of the body, thermography and vision. P: Physics 201 and 202 or Physics 207 and 208.

410 Radiobiology. (Crosslisted with Human Oncology 410.) Every other Spring in even years, 2 cr. Effects of ionizing radiations on living cells and organisms, including physical, chemical, and physiological bases of radiation cytotoxicity, mutagenicity, and carcinogensis. Two lectures per week. Ritter. P: One yr. each of biology, physics and organic chemistry, or con. of inst.

Date /Time	Subject Matter
	1. Atomic and Nuclear Structure **A.** The atom - Protons, Neutrons, Electrons (charge, rest mass) - Atomic Number and Atomic Mass - Orbital electron shells (binding energy, transitions) - Wave and quantum models of radiation - Energy and wavelength, energy spectrum
	1. Atomic and Nuclear Structure (contd.) **B.** Radioactivity and decay - Decay processes (of commonly used isotopes for imaging/therapy as appropriate) - Probability and decay constant - Activity, half life, mean life - Radioactive series
	2. Production of X-rays, photons and electrons **A.** Basic physics of X-ray beam production - Bremsstrahlung production of X rays - Characteristic radiation - Diagnostic X-ray tube design - X-Ray Energy spectrum
	2. Production of X-rays, photons and electrons (contd.) **B.** Generation of Beams - X-ray energy spectra and filtration - Gamma- radiation teletherapy sources (Co-60) - - Linear accelerator production of X rays and electrons
	3. Treatment Machines, Generators and Simulators **A.** Linear accelerators - Operational theory of wave guides - Bending magnet systems - Photon beam Delivery - Electron beam delivery - Beam energy - Monitor chamber
	3. Treatment Machines, Generators and Simulators (contd.) **B.** Linac Collimation systems and other Teletherapy - Primary and secondary collimators - Multileaf collimators - Other collimation systems (radiosurgery) - Radiation and light fields (including field size definition) - Cobalt units (Gamma Knife)

	X-Band Systems (CyberKnife, Mobetron) - Therapeutic x-ray (<300 kVp)
	3. Treatment Machines, Generators and Simulators (contd.) **C.** Simulators - Mechanical and Radiographic Operation - Fluoroscopy, flat panel detectors, and Intensifiers - CT Simulation Machinery - CT Simulation Operation - Simulators with CT capability
	4. Radiation Interactions **A.** Interactions of X and γ rays with matter - Scatter vs. absorption of radiation - Coherent scatter - Photoelectric effect - Compton effect - Pair production - Photonuclear disintegration
	4. Radiation Interactions (contd.) **B.** Attenuation of Photon Beams - Attenuation, energy transfer, and energy absorption - Exponential attenuation equation - Attenuation coefficients - Half-value layer - Beam geometry
	4. Radiation Interactions (contd.) **C.** Interactions of particulate radiation - Directly and indirectly ionizing particles - Elastic and inelastic collisions with orbital electrons and the nucleus - Linear energy transfer, specific ionization, mass stopping power, range - Interactions of electrons - Interactions of heavy charged particles (i.e. protons) - Interactions of neutrons
	5. Radiation Beam Quality and Dose **A.** Monoenergetic and Polyenergetic bremsstrahlung beams - Energy spectra for bremsstrahlung beams - Effects of electron energy, filtration, beam geometry - Homogeneity coefficient - Effective energy

	- Clinical indices for megavoltage beams (e.g., PDD at reference depth)
	5. Radiation Beam Quality and Dose (contd) **B.** Dose quantities and units - evolution of dose units - kerma - exposure - Absorbed dose
	5. Radiation Beam Quality and Dose (contd) **C.** Relationships of kerma, dose, exposure - Dose equivalent - RBE dose - Calculation of absorbed dose from exposure - Bragg-Gray cavity theory
	6. Radiation Measurement and Calibration **A.** Calculation of Dose - Calculation of Absorbed Dose from Exposure - historical perspective (in light of TG51) - Bragg-Gray Cavity Theory - Stopping Powers, Effective Point of Measurement
	6. Radiation Measurement and Calibration (contd.) **B.** Dose Output Calibration - Ionization Chambers (cylindrical, Parallel-Plate Calibration of Megavoltage Beams Photon beams Electron beams Dose calibration parameters TG-51(theory and overview) Exposure from Radioactive Sources Other Methods of Measuring Absorbed Dose Calorimetry Chemical Dosimetry (Fricke solution, BANG co-polymer gel dosimetry)
	6. Radiation Measurement and Calibration (contd.) **C. Clinical Dosimetry** Solid State Detectors TLDs Diode detectors FET detectors Detector arrays (for IMRT/TomoTherapy verification) Film Dosimetry (IMRT verification dosimetry) XV2 film

	EDR2 film Radiochromic film Processors
	7. Photons and x-rays Characteristics and Dosimetry **A.** External Beam Dosimetry Concepts (Part I) 1. Dosimetric Variables from Calibration - Inverse Square Law - Backscatter factor - Electron Buildup - Percent Depth Dose Mayneord F-factor Definition of area (collimator, scatter, patient) - Equivalent Squares
	7. Photons and x-rays Characteristics and Dosimetry (contd.) **B.** External Beam Dosimetry Concepts (Part II) - Primary vs. Scatter - Scatter to Primary Ratio - Tissue-phantom Ratio - Tissue-maximum Ratio Converting PDD to TMR Dose Normalization and Prescription
	7. Photons and x-rays Characteristics and Dosimetry (contd.) **C.** System of Dose Calculations 1. Monitor Unit Calculations a) Calibration b) Collimator Scatter Factor and Phantom Scatter Factor c) Field Size Correction Factors d) Beam Modifier Factors (wedges) e) Patient Attenuation Factors f) Output Factor 2. Calculations in Practice a) SAD Technique 1. SAD Treatment and SAD Calibration 2. SAD Treatment and SSD Calibration 3. SAD Rotational Treatment b) SSD Technique 1. SSD Treatment same as SSD of Calibration 2. SSD Treatment Different from SSD of Calibration 3. SSD Treatment and SAD Calibration

	c) Calculation of Maximum Dose in parallel opposed field plans
	7. Photons and x-rays Characteristics and Dosimetry (contd.) **D.** Translation of Computerized Planning 1. Beam Models (i.e. Convolution) 2. Flatness and symmetry of beam profiles 3. Isodoses 4. Beam Combination (2-, 3-, 4-, 6- field techniques) 5. Beam Weighting 6. Irregular Fields 7. Bolus 8. Arc rotation therapy
	7. Photons and x-rays Characteristics and Dosimetry (contd.) **E.** Computerized Treatment Planning Strategies 1. Surface and Buildup Dose 2. Entrance and Exit Dose 3. Penumbra 4. Wedge Isodose Curves and Techniques a) Wedge Angle and Hinge Angle b) Wedge Factor 5. Wedge and Compensator Techniques a) Wedge Pair b) Open and Wedged Field Combination c) Custom Compensators d) different types of wedges (universal, dynamic, physical, segmentation)
	7. Photons and x-rays Characteristics and Dosimetry (contd.) **F.** Surface Corrections & Heterogeneity Calculations 1. Effects and Corrections for Surface Obliquities 2. Corrections and Limitations for Inhomogeneities a) Simple 1-D and 2-D Methods b) Convolution and Superposition Methods c) Monte Carlo Methods d) Dose Perturbations at Interfaces
	7. Photons and x-rays Characteristics and Dosimetry (contd.) **G.** Adjoining fields & Special Dosimetry Problems 1. Two-Field matching 2. Three-Field matching 3. Craniospinal field matching

	4. Treatment considerations for Pacemaker and Defi 5. Gonadal Dose, measurement and minimization 6. Pregnant Patient, considerations and dosimetry
	8. Electron Beam Characteristics and Planning **A.** Basic Characteristics - Depth-dose characteristics - Electron interactions - CSDA and range - Dose versus depth - Electron Skin Dose - Isodoses - Oblique incidence
	8. Electron Beam Characteristics and Planning (contd.) **B.** Treatment Planning with Electrons - Selection of energy, field size - Bolus for surface buildup Bolus for depth-range compensation - Field Shaping - Electron-electron matching - Electron-photon matching - Electron Backscatter dosimetry - Inhomogeneities - Internal shielding - External shielding (i.e, eye shields, brems production, energy and shielding material thickness)
	9. External Beam Quality Assurance **A. Overview of Quality Assurance in Radiation Therapy** Goals, Regulations Continuing Quality Improvement vs. QA Staffing Roles, training, duties & responsibilities of individuals Equipment Specifications Error Analysis and Prevention CT-Simulators Conventional Simulators Processors
	9. External Beam Quality Assurance (contd.) **B.** Linac and Imaging QA Acceptance Testing – Linac Commissioning – Linac Data Required Treatment Planning Commissioning and Quality

	Assurance Routine Quality Assurance and Test Tolerance Daily QA Monthly QA Yearly QA Quality Assurance of Imaging Apparatus Portal imagers CT-Simulators Conventional Simulators Processors
	10. Informatics DICOM PACS Network Integration and Integrity Storage and Archival IS Maintenance Physics and IT Staff Roles
	11. Radiation Protection and Shielding **A.** Radiation Safety 1. Concepts and Units - Radiation Protection Standards - Quality Factors - Definitions for Radiation Protection - Dose Equivalent - Effective Dose Equivalent 2. Types of Radiation Exposure - Natural Background Radiation - Man-Made Radiation - NCRP #91 Recommendations on Exposure Limits 3. Protection Regulations a) NRC Definitions 1. Medical Event 2. Authorized User b) NRC Administrative Requirements 1. Radiation Safety Program 2. Radiation Safety Officer 3. Radiation Safety Committee c) NRC Regulatory Requirements (including security) d) Personnel Monitoring
	11. Radiation Protection and Shielding (contd.) **B.** Radiation Shielding 1. Treatment Room Design a) Controlled/Uncontrolled Areas b) Types of Barriers

	c) Factors in Shielding Calculations 1. Workload (W) 2. Use factor (U) 3. Occupancy factor (T) 4. Distance 2. Shielding Calculations (including IMRT) 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 1. Ionization chamber (Cutie Pie) 2. Geiger-Mueller Counters 3. Neutron Detectors 5. Shielding requirements for conventional simulators, CT simulators 6. HDR units (linac vault vs. dedicated bunker) 7. Special Procedure shielding (TBI)
	12. Imaging for Radiation Oncology **A.** Radiography Fundamentals Diagnostic Imaging physical principles Physical principles Impact on quality systems Port Film Imaging Film types and cassettes Electronic Portal Imaging Overview of electronic portal imaging devices Types of portal imaging devices Clinical applications of EPID technology in daily practice kV flat panel detectors room mounted systems gantry mounted systems
	12. Imaging for Radiation Oncology (contd.) **B.** CT and PET CT principles of image formation (Hounsfield numbers, CT numbers, etc.) systems (large bore, small bore, single/multi detector, conebeam and FOV)

	factors influencing image artifacts image quality dose PET principles of image formation detection reconstruction (brief) quantitative use of PET (SUV) artifacts
	12. Imaging for Radiation Oncology (contd.) **C.** MRI and Ultrasound MRI Scanning Physical principles of image formation signal generation sources of contrast artifacts T1, T2, TE, TR imaging characteristics Advantages & limitations of MRI Ultrasound Physical principles of image formation Systems (endorectal, volumetric, planar) Utility in diagnosis and patient positioning Artifacts and image distortion
	12. Imaging for Radiation Oncology (contd.) Use of Imaging in Treatment Planning Image Registration Contrast Agents Image Fusion Advantages Challenges Techniques Limitations (deformable body) Hybrid Systems (incl. SPECT) Quality assurance Image transfer process Imager QA
	13. 3DCRT including ICRU concepts and beam related biology **A.** 3DCRT concepts volumetric (3DCRT) vs. non-volumetric Technology and methods for planning (volume based planning) Building patient models (image reconstruction and segmentation) Virtual simulation Implications of treatment variabilities

	systematic and random setup variabilities, patient breathing ICRU Report 62: (Supplement to ICRU Report 50)
	13. 3DCRT including ICRU concepts and beam related biology (contd.) **B.** Volumetric Beam Placement DRR Generation BEV, DVH Non-coplanar beams Planning Tools - Biological implications of uniform vs. non-uniform dose delivery - Non-biological and biological dose-volume metrics (DVHs, TCPs, NTCPs) - Margins (PTVs, PRVs)
	13. 3DCRT including ICRU concepts and beam related biology (contd.) **C.** Treatment Planning Methods Beam Selection 4D Imaging and Planning Dose Reporting Volumetric vs. Point Prescriptions
	14. Assessment of Patient Setup and Treatment **A. Positioning and immobilization methods and devices** - Table coordinates, lasers, distance indicators - Positioning options (calibrated frames, optical and video guidance, etc.) - Breathing maintenance - Immobilization methods (thermoplastic masks, bite blocks, etc.)
	14. Assessment of Patient Setup and Treatment (contd.) **B. Treatment Verification** Image Based - Radiographic - Cone-beam CT MVCT Internal markers (eg, implanted fiducials) Non-image based Ultrasound - Video imaging Electromagnetic sources - On-line correction of setup errors

	Dosimetry based Diodes TLDs MOFSET Adaptive planning concepts
	15. IMRT **A.** IMRT Delivery Systems Segmental MLC (SMLC) and Dynamic MLC (DMLC) Serial Tomotherapy (MIMiC) Helical Tomotherapy Robotic Linac Compensators
	15. IMRT (contd.) **B.** Dose prescription & inverse planning Discuss concept of PRVs Forward and inverse planning components Key components of planning system (optimization) Planning Evaluation Isodoses, DVH Deliverability Hot Spots
	15. IMRT (contd.) **C.** IMRT Quality assurance Commissioning of Planning and Delivery Systematic QA Patient specific QA tools and metrics Chambers, film, EPID, Monte Carlo Calculations Delivery QA Record/verify Machine treatment delivery records
	16. Special Procedures **A.** Delivery and Positioning Stereotactic Systems Linac based Gamma Knife Robotic Linac Extracranial Positioning and Immobilization Frames ESRT Frameless
	16. Special Procedures (contd.) **B.** SRS Dose prescription & planning, QA Prescriptions

	Dosimetry Outputs Profiles TP Commissioning Delivery Options Arc Therapy MLC Based Quality Assurance
	16. Special Procedures (contd.) **C.** Other Special Procedures Photon Total Body Irradiation - Simulation - Patient Set-up (Lateral, AP/AP, multifield: advar - Dosimetry - Selection of energy, field size, distance, dose-rate - MU calculations TSET Electron Arc
	17. Brachytherapy **A.** Radioactive Sources (General Information) and Calibration - Radium – disadvantages of radium, effect of source casing - Cesium-137 - Cobalt-60 - Iridium-192 - Gold-198 - Iodine-125 Cs-131 Pd-103 - Specification of Source Strength - Linear Sources - Seeds - Exposure Rate Calibration
	17. Brachytherapy (contd.) **B.** Calculations of Dose Distributions - Biological considerations of dose, dose rate, and fractionation - Calculation of dose from a point source (TG-43) - Calculation of dose from a line source
	17. Brachytherapy (contd.) **C.** Implantation Techniques Remote and Manual - Surface Molds/Plaques - Interstitial Therapy

	Prostate Brachytherapy HDR vs. LDR treatments Planning Techniques - Uniform vs Peripheral -Breast Brachytherapy -Single Catheter v Multiple Catheter Planning
	17. Brachytherapy (contd.) Gynecological Implants - General Information (advantage/disadvantage) - Remote Afterloading Units - HDR vs. LDR - Intracavitary Therapy - Uterine Cervix - Milligram-Hours - Manchester System - Bladder and Rectum Dose - ICRU System - Absorbed Dose at Reference Points
	17. Brachytherapy (contd.) **E.** Systems of Implant Dosimetry Historical (Paterson-Parker) Computerized TP Process and Calculations Units, Decay Applicators Limitations Imaging
	17. Brachytherapy (contd.) **F.** Quality Assurance and Safety Quality Assurance Placement Verification TP Accuracy Applicator Integrity Safety Detectors - Regulatory Requirements - Surveys - Inventory and Wipe Tests - Shipping and Receiving Source Handling
	18. Radiopharmaceutical physics and dosimetry **A.** Methods of production and Clinical treatments - Reactor-produced isotopes - Cyclotron-based production - Radiochemistry basics Clinical treatments using internally administered radioisotopes

	- Iodine treatment for thyroid - Radioimmunotherapy - Emerging treatments
	18. Radiopharmaceutical physics and dosimetry (contd.) **B** Internal dosimetry and Safety - Dosimetry systems - Compartmental models MIRD method Dose estimates for embryo/fetus and breast-feeding infant Radiation safety - Equipment Survey meters, NaI probes, well counters, radionuclide calibrators Instrument quality controls and checks - Safety procedures Radiation protection, including internal protection, spill response and decontamination, inpatient and outpatient therapy precautions, written directive, medical event, radioactive package receipt, and area surveys/removable contamination wipe tests - Regulations
	19. Hyperthermia Physics Aspects of Hyperthermia The bio-heat equation and simplified solutions. Specific Absorption Rate (SAR). Thermal aspects of blood flow/perfusion External superficial electromagnetic hyperthermia applicators. Interstitial electromagnetic hyperthermia applicators Ultrasound hyperthermia systems Electromagnetic applicators for regional hyperthermia Thermometry performance criteria, tests, and artifacts.
	20. Particle Therapy Cyclotrons and Synchrotrons Protons - Proton Beam Energy Deposition –RBE - Equipment for Proton Beam Therapy - Clinical Proton Beam Dosimetry range modulation

	spot-scanning vs. passive scattering, beam penumbra - Clinical Proton Beam Therapy - Treatment Planning Neutrons - Fast vs. slow Neutron Production Boron Neutron Capture - Accelerator Requirements - Clinical Beam Dosimetry – basic PDD curves for neutron beams Safety and Shielding for Protons and Neutrons
	Total