Jordan University of Science and Technology

Faculty of Science & Arts

Physics Department

PHY783 Medical Physics
First Semester 2017-2018

Course Catalog
3 Credit Hours. This course aims to present the physical principles of X-ray production and factors affecting its quality and intensity, absorption of x-ray in materials, making an x-ray image, processing and quality of radiographic films, producing live radiological images, radiation protection. On the other hand the course also aims to introduce the principles of Radiotherapy. It includes: radiation sources, Radiotherapy with single photon beams, Radiotherapy with particle beams, treatment planning, techniques and equipment in teletherapy and brachytherapy, dosimetry using small sealed sources and radionuclide sources, radiation protection.

Text Book	
Title	Physical Principles of Medical Imaging
Author(s)	Perry Sprawls
Edition	2nd Edition
Short Name	1
Other Information	

Course References

Short name	Book name	Author(s)	Edition	Other Information
2	Applied Physics for Radiation Oncology	R. Stanton and D. Stinson	1st Edition	
3	Physics for Diagnostic Radiology	P P Dendy and B Heaton	2nd Edition	
4	Principles of Radiological Physics	Robin Wilks	2nd Edition	

Instructor	
Name	**Prof. Mohammed-Ali Al-Omari**
Office Location	PH3 L1
Office Hours	
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Class Schedule & Room
Section 1: Lecture Time: Mon, Wed : 08:30 - 10:00 Room: SF06

Tentative List of Topics Covered

Weeks	Topic	References
Week 1	X-ray tube basic design - Anode, cathode, grid, envelope, filtration, housing. Electrical quantities such as kVp and mA Production of Bremsstrahlung, characteristic radiation, Efficiency of X-ray production and Efficacy (Output). Some basic ideas about filtration.	
Week 2	Energizing and Controlling the X-ray tube. KV production (Single phase, three phase, constant potential), Rectification (Half wave, full wave), voltage waveform, capacitors, high frequency power supplies, mA control, exposure timing, X-ray tube Heating and Cooling ? Heat production, Heat capacity, Focal spot area, Anode body and construction, Tube housing. Relationship between kVp, mAs and waveform.	
Week 3	X-ray beam quality and typical x-ray spectra, from different types of radiology X-ray equipment. HVL, relationship to attenuation coefficient, and TVL Filtration. Types of filters, (Al, Cu, Mo), added filtration, spatial filtration. Concepts and principles of patient exposure reduction. Effects and benefits of Grids and Filtration	
Week 4	Characteristics of contrast-producing materials, Soft tissue, calcium and bone, Iodine, Gas and their interaction at different photon energies KV selection ? examples in mammography, extremities, vascular (iodine) Abdominal (Barium) Chest Visibility of detail, relationship to blurring and object size General overview of the photographic process ? Image contrast ? concept, units, film density units, brightness units and effect on visibility, area contrast and effect on visibility. Subject Contrast ? concept and relationship to image contrast. Image formation ? principles of projection X-ray imaging, Other characteristics such as resolution and sharpness Motion blurring, In the object plane and the receptor plane. Focal spot blurring, source, relationship to focal spot size, relationship to object location. Receptor blurring, sources of blur, types of receptors (intensifying screens), relationship to object location and magnification.	
Week 5	Radiographic Quality Noise and image quality. Types of noise, film, intensifier structure. MTF?s Quantum noise ? source, relationship to exposure, standard deviation, relationship to blur and image detail, relationship to film contrast. Relationship of contrast to scatter. Grids, grid penetration, contrast improvement. Grid interference, focal distance, decentering and angulation. Grid selection, Collimators, types and effects on scattered radiation. Types used in fluro work (positive beam collimation) Air gaps.	
Week 6	Film Imaging (Processing of Radiographic Images) Function, image recording, image display, image storage. Optical density, light penetration and density, density values, film structure. The photographic process, latent image formation, development, fixing, washing, silver recovery Sensitivity, composition, processing, Light color, exposure time. Contrast transfer, relationship of radiographic and subject contrast. The characteristic curve, contrast factor (slope) gamma, average gradient, Latitude. Factors that alter contrast ? exposure, film type, processing. Quality control procedures.	
Week 7	Radiographic Technique and Film Density Control Exposure controls, kVp, mAs, time, exposure charts. Receptor sensitivity, film, intensifier (screen and tube) Machine output, quantity (exposure, Quality (penetration). Distance, patient penetration, thickness, kV, condition (composition) Field size. Technique conversion.	

Week 8	Radiographic Quality cont. Intensifying screens, Cassettes and changers, screen design and function. Screen sensitivity, x-ray absorption, screen materials, photon energy, screen thickness, conversion efficiency, light production and efficiency, light wavelength and optical properties. Effects on image detail, sources of blur, thickness, contact with film, crossover, relationship of detail to sensitivity, screen types, screens for special purposes. Quality control procedures for grids, Collimators, intensifying screens, film changer.	
Week 9	Fluoroscopic Systems Image intensifier ? construction, input phosphor, photocathode, electron lens, output phosphor, basic operation, intensification, gain factor conversion factor. The optical system - description and function, collimating lens, beam splitter, aperture, camera lens. Image formation ? image size and framing, image brightness. Video principles ? camera tubes, CRT (picture) tubes, scanning, synchronization. Video and image quality ? contrast, vertical blur, horizontal blur, image noise. Automatic brightness control. Video recorders	
Week 10	Computed Tomography X-ray tube design. Detector systems. Views ? different generations. The scan and data collection Image reconstruction ? filtered back projection. The CT image ? pixels and voxels, CT numbers. Image quality ? comparison to radiography, greater contrast sensitivity, less visibility of detail, more noise, more artifacts Examples of CT scanners and their specifications. Contrast sensitivity, tomography windowing, scattered radiation, Visibility of detail, noise, CT number accuracy, examples of CT images and artifacts. CT QA and doses. Examples of CT slides	
Week 11	Mammography Tube design, focal spot sizes, energies used, films, things specific to mammography in the design. Target design. Show examples of films. Doses in mammography. Types of machines (screening and diagnostic) Quality Assurance in mammography	
Week 12	Radiation Protection for Diagnostic Radiology International Commission on Radiological Protection (ICRP) concepts of justification, optimization and dose limitation; the ALARA principle; International Basic Safety Standards; statutory responsibilities, relevant legislation and Codes of Practice; controlled and supervised area, staff classification.	
Weeks 12, 13	Risks in Diagnostic Radiology Radiation protection quantities and units, Stochastic and deterministic effects of radiation. The linear no-threshold model, Risk vs benefit in Diagnostic Radiology, Doses in diagnostic radiology. Effective dose and its measurement Dose reduction in diagnostic Radiology	
Week 14	Radiation Protection Shielding Radiation Shielding ? Basic terminology, transmission, workload, design limits, occupancy factors Shielding ? NCRP 49 concepts Radiation Shielding examples, Practical Assessment of Shielding, Distribution of workload with kVp, Shielding for various diagnostic facilities, Shielding materials, Personnel protection.	
Week 15	General Revision	

Mapping of Course Objectives to Program Student Outcomes[1]	**Assessment method**
Know the introduction to the important parameters in the production of X-rays for diagnostic radiology	
understand the quality and intensity of X-ray beams and how they interact in matter	
Know the production and processing of the radiological image	
Know the different types of radiological images found in diagnostic radiology	
Understand the radiation protection and the risks in diagnostic radiology	

Become familiar with: - The principles of radiation therapy physics. - The role of radiotherapy in cancer management. - The physical process of radiation generation, transport and interaction with matter. - The physics of radiation protection in radiotherapy.	
Appreciate the importance of radiation dose in radiotherapy	

Relationship to Program Student Outcomes (Out of 100%)										
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)

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The Physical Principles of Medical Imaging, 2nd Ed. NIST. Interaction of Radiation With Matter: Charged Particle and Electron Interactions. AN4 Interaction of Radiation With Matter. Radiation Dosimetry, by John Cameron. 6 Equations of Radioactive Decay and Growth. Radioactive Decay. Treatment Machines for External Beam Radiation. Start by marking â€œPhysical Principles Of Medical Imagingâ€ as Want to Read: Want to Read savingâ€¦ Want to Read. Currently Reading. Read. Physical Principles Of by Perry Sprawls. Other editions.Â Medical imaging has been explained easily and the concepts on X-ray, Computed Tomography and MRI has been covered in a systematic way. What is even better is that the resources for teaching are available online for free by the author and publisher. flag Like Â· see review. This survey course will cover basic physical, biochemical, computational and engineering principles underlying current medical imaging techniques, including magnetic resonance imaging, positron emission tomography, radionuclide production and radiochemistry, optical imaging, X-ray computed tomography and ultrasound. The goal of the course will be to provide students with a broad knowledge of the concepts and implementation strategies of various imaging methods relevant in current research and clinical practice. Practical applications will be used to illustrate the main themes of the course. To

This is a companion textbook to Physical Principles of Medical Imaging Online, Resources for Learning and Teaching http://www.sprawls.org/resources. Note: The web links are activated below as each chapter is converted to electronic format and becomes available on the web. Image Characteristics and Quality.Â The chapters on magnetic resonance imaging are now published in: Magnetic Resonance Imaging: Principles, Methods, and Techniques. Perry Sprawls. Medical Physics Publishing, Madison, Wisconsin.

This introduction to medical imaging introduces all of the major medical imaging techniques in wide use in both medical practice and medical research, including Computed Tomography, Ultrasound, Positron Emission Tomography, Single Photon Emission Tomography and Magnetic Resonance Imaging. Principles of Medical Imaging for Engineers introduces fundamental concepts related to why we image and what we are seeking to achieve to get good images, such as the meaning of â€˜contrastâ€™ in the context of medical imaging.Â The text considers firstly the underlying physical principles by which information about tissues within the body can be extracted in the form of signals, considering the major principles used: transmission, reflection, emission and resonance. Principles of Medical Imaging. background of a wide range of normality. This requires an informed qualitative judgement on the part of the clinician. When imaging forms part of an investigation, its results often provide another partial clue to the solution of a complex puzzle, rather than a single definitive answer. The increasing use of quantitative measurement and computers in clinical medicine is gradually changing the traditional education of medical students.Â Principles of Medical Imaging. The Second Law Newtonâ€™s second law relates force and acceleration. It is possibly the most important relationship in all of physics. A force on an object will produce an acceleration or change in velocity. ABSTRACT: Information on physical image quality of medical images is important for imaging system assessment in order to promote and stimulate the development of state-of-the-art imaging systems. In this paper, we present a method for evaluating physical performance of medical imaging systems. In this method, mutual information (MI) which is a concept from information theory was used to measure combined properties of image noise and resolution of an imaging system. In our study, the MI was used as a measure to express the amount of information that an output image contains about an input objec