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**
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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 properties of ultrasound, particularly its highly directional beam behaviour, and its complex interactions with human tissues, have led to its becoming a vitally important tool in both investigative and interventional medicine, and one that still has much exciting potential. This new edition of a well-received book treats the phenomenon of ultrasound in the context of medical and biological applications, systematically discussing fundamental physical principles and concepts.Â Real tissues attenuate and scatter ultrasound in ways that have interesting relationships to their physical chemistry, and the book includes coverage of these topics.