MANGALORE UNIVERSITY

MSc Medical Physics

MPH 502: Physics of Medical Imaging

Teaching hours: Each Unit – 12 h

Objective:

To familiarise the students with different diagnostic techniques and underlying principlesin formation of images using X-Rays, MRI and Ultrasound radiations, also acquainting the image analysis methods in radiotherapy planning.

Outcomes:

- The students will understand the role of radiation interaction with different tissues, their attenuation coefficients and other process involved in forming the radiographic images used in diagnosis.
- They learn about materials and methods used including prime parameters of X- rays in producing clear and quality images. Familiarise with quality assurance programme for diagnostic radiology.
- Students will be familiar with digital X-ray imaging; mammography; computed tomography and their different techniques and applications.
- They will know the details of Magnetic Resonance Imaging (MRI) and its applications including the safety aspects.
- Interaction of ultrasound with body tissue, image formation, and the methods employed in diagnosis including colour Doppler and their applications will be understood.

Unit I: Principles of X-ray Diagnosis & Conventional Imaging

Physical Principle of diagnostic radiology: Interactions of X-rays with human body, differential transmission of X-ray beam, spatial image formation, visualization of spatial image, limitations of projection imaging technique viz. superimposition of overlying structures and scatter, application of contrast media and projections at different angles to overcome superimposition of overlying structures.

Unit II: Radiography techniques

Prime factors (kVp, mAs and SID/SFD), influence of prime factors on image quality, selection criteria of prime factors for different types of imaging, different type of projection and slices selected for imaging, objectives of radio-diagnosis, patient dose Vs Image quality. Filtration: Inherent and added filters, purpose of added filters, beryllium filters, filters used for shaping X-ray spectrum (K-edge filters: holmium, gadolium, molybdenum).

Scatter reduction: Factors influencing scatter radiation, objectives of scatter reduction, constrast reduction factor, scatter reduction methods; beam restrictors (diaphragms, cones/cylinders & collimators), grids (grid function, different types of stationary grids, grid

performance evaluation parameters, moving grids, artifacts caused by grids, grid selection criteria), air gap technique. Intensify screens: Function of intensifying screens, screen function evaluation parameters, emission spectra and screen film matching, conventional screens Vs rare earth screens. Radiographic Film: Components of Radiographic Film, physical principle of image formation on film, double and single emulsion film, sensitometeric parameters of film (density, speed, latitude etc.) QA of film developer.

Image quality: Image quality parameters: sources of un-sharpness, reduction of un-sharpness factors influencing radiographic contrast, resolution, factors influencing resolution, evaluation of resolution (point spread function (PSF), line spread function (LSF), edge spread function (ESF), modulation transfer function (MTF), focal spot size evaluation. QA of conventional diagnostic X-ray equipment: Purpose of QA, QA protocols, QA test methods for performance evaluation of x-ray diagnostic equipment.

Unit III: Digital X-ray imaging and Computed Tomography

Xero-radiography, mammography, fluoroscopy, digital radiography (CR and DR systems), digital subtraction techniques, Conventional tomography (Principle only), orthopan tomography (OPG), Computed Tomography (CT), QA of CT equipment.

Unit IV: Magnetic Resonance Imaging (MRI)

Magnetic Resonance image – proton density, relaxation time T1 & T2 images – Image characteristics – MRI system components – Magnets, Magnetic fields, Gradients, Magnetic field shielding, Radio Frequency systems, Computer functions – Imaging process – Image artifacts – MRI safety.

Unit V: Ultrasound Imaging

Interaction of sound waves with body tissues, production of ultrasound – transducers – acoustic coupling – image formation – modes of image display – colour Doppler.

Reference Books:

1. –The Essential Physics of Medical Imaging‖ Jerrold T Bushberg, Second Edition 2002, LWW.
2. –Introduction to Medical Imaging Physics, Engineering and Clinical
3. Applications‖ N. Smith and A. Webb 2011,Cambridge University Press
4. W.J. Meredith and J.B. Massey –Fundamental Physics of Radiology‖ John Wright and Sons, UK, 1989

5 Christensen _Physics of Diagnostic Radiology' Lea and Febiger – Philadelphia (1990).
6 W.R. Hendee, -Medical Radiation Physics|, Year Book – Medical Publishers Inc. London, 1981
7. P. Sprawls, Magnetic Resonance Imaging: Principles, Methods and Techniques, Medical Physics Publishing, Madison (2000)
8 Curry,T.S. Dowdey,J.E. Murry,R.C,(1990), Christensen's introduction to the Physics of diagnostic radiology, 4th edition, Philadelphia,Lea&Febiger
9 Bushberg,S.T; Seibert,J.A; Leidholt,E.M&Boone,J.M.(1994), The essential Physics of Medical imaging, Baltimore, Williams & Wilkins.
10 David J. Dowsett; Patrick A. Kenny; Eugene Johnston R. The Physics of Diagnostic imaging
11 Hendee,W.R. &Ritenour,R.(1993) Medical Imaging Physics, 3rd edition
12 Dendy,P.P. &Heaton,B. Physics for diagnostic radiology, 2nd edition
13 Hashemi,R.H. Bradley, W.G;&Lisanti C.J. MRI the basics.
14 RF Farr and PJ Allisy-Roberts Physics for Medical Imaging
15 Sprawls,P; Magnetic resonance imaging principles, methods and techniques

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