Medical Physics

(Elective for 3rd Semester) From 2025-26

Total: 39 hours

Unit I: X Rays Basics **(12 hours)**

Qualitative Overview of human anatomy - cells, cell structure, type of cells and functions, tissues, organs, and their functions. Different systems in the human body, their structure and function, physiological properties of the circulatory system, digestive system, respiratory system, reproductive system, excretory system, endocrine system and nervous system. (03 Hours)

Outline of atomic structure, electromagnetic radiation waves and quanta, general properties of electromagnetic radiation- fundamentals of radioactivity radiations (alpha, beta and gamma). Light- intensity and quality, spectrum of white light, line spectra, photo-electric emission, photocell, fluorescence, phosphorescence. (05 Hours)

Principle, and production of X rays, Conditions necessary for production of x-rays, Heterogeneous nature of the x-ray beam, Electron emission, electron acceleration through electric field, Types of x-ray tubes: diagnostic, therapeutic, stationary anode, rotating anode, gas tubes (ionic), Coolidge tubes (thermionic) (04 Hours)

Unit II: Interaction of X-rays with Human body, Basics of Laser **(12 hours)**

Properties of x-rays, frequency, energy, the effect of voltage on these properties, absorption of x-rays, the absorption of primary radiation in striking matter, Secondary, scattered and characteristic radiation, Detection of x-radiation, action on the emulsion of the photographic film, physiological action on living tissue, ionizing effects. Unit of ionizing radiation quantity, the roentgen., Permissible dosage for x-ray operators (0.3 r per week) (04 Hours)

Interaction of X-rays with human body. Effect of x-ray exposure on human body, x-ray protection, permissible exposure, international recommendations for protection of persons exposed to ionizing radiation, the protective materials lead, Lead Aprons, building materials, lead equivalents and variation with quality and room protection, Use of X-rays in medical diagnosis, X-ray imaging systems. (04 Hours)

Laser : Induced absorption, spontaneous emission and stimulated emission. Einstein's A and B coefficients – Mention of relation between Einstein's coefficients and radiation energy density; Condition for amplification of light; Population inversion; Methods of pumping (qualitative); Requisites of laser – energy source, active medium and laser cavity; Qualitative discussion about Helium-Neon Laser and Ruby Laser, Characteristics of laser light and its applications. (medicine, industry and defence). (04 Hours)

Unit III: Radiation Technology (Medical Diagnostics) (12 Hours)

Computed Tomography scan (CT scan): principle and generation of CT. – Basic Physics – Recent developments, applications etc. (02 Hours)

NMR (Nuclear Magnetic resonance) (Qualitative), MRI–Magnetic Resonance Imaging – basic principle and image characteristics. Strength of typical magnetic field, methods of production of high magnetic field, Superconducting coils, Effect of magnetic field on human body, Basic terms used in MRI Operations, Applications. (05 Hours)

Ultrasonics, – Ultrasound Imaging: Interaction of sound waves with body tissues, production of ultrasound, transducers, acoustic coupling, image formation, modes of image display and color Doppler. Types of ultrasound – Techniques of ultrasound scanning in different parts. (05 Hours)

Student activities and Mini Project: (09 hours)

The Student shall carry out following activities and understand the fundamentals and basics of X-Rays, CT, MRI and USG. He/she shall prepare a mini project report signed and attested, preferably by Radiologist/Lab technician. **It will be evaluated for 10 marks by staff in charge and shall be considered as Internal Assessment Marks.**

Student Activities:

1. Construction of models of human anatomy and physiology.
2. Visit to nearby hospitals/diagnostic centers to study the working of X-ray machines, X-ray films, CT Scan, MRI and USG..
3. Visit to radiotherapy centers to study the modalities of radiotherapy.

Text Books

1. C. H. Best and N. B. Taylor. A Test in Applied Physiology. Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick. Anatomy and Physiology for Radiographers. Oxford University Press, 2001.

3. Jerrold T. Bushberg. The Essential Physics for Medical Imaging (2nd Edition). Lippincott Williams & Wilkins, 2002.
4. Jean A. Pope. Medical Physics: Imaging. Heinemann Publishers, 2012.
5. Faiz M. Khan and Roger A. Potish. Treatment Planning in Radiation Oncology. Williams and Wilkins, USA, 2003.
6. D. Baltas. The physics of modern brachytherapy for oncology. Taylor and Francis, 2007.

Reference Books

1. J. R. Brobek. Physiological Basis of Medical Practice. Williams and Wilkins, London, 1995.
2. Edward Alcamo, Barbara Krumhardt. Barron's Anatomy and Physiology the Easy Way. Barron's Educational Series, 2004.
3. Lippincott, Anatomy and Physiology. Lippincott Williams & Wilkins, 2002.
4. W. E. Arnould Taylor. A textbook of anatomy and physiology, Nelson Thornes, 1998.
5. G. S. Pant. Advances in Diagnositc Medical Physics. Himalaya Publishing House, 2006.
6. Sabbahaga, Diagnositc Ultrasound applied to OBG. Maryland, 1980.
7. Faiz M Khan. The Physics of Radiation Therapy (3rd edition). Lippincott Williams & Wilkins, USA, 2003.
8. Jatinder R. Palta and T. Rockwell Mackie. Intensity Modulation Radiation Therapy. Medical Physics publishing, Madison, Wisconsin, 2003.
9. AAPM Report No. 72. Basic Applications of Multileaf collimators, AAPM, USA, 2001.
10. AAPM Report No. 91. Management of Respiratory motion in radiation oncology, 2006.
11. CA Joslin, A. Flynn, E. J. hall. Principles and Practice of Brachytherapy. Arnold publications, 2001.
12. Peter Hoskin, Catherine Coyle. Radiotherapy in Practice. Oxford University Press, 2011.
13. W. R. Handee. Medical Radiation Physics. Year Book Medical Publishers Inc., London, 2003.
14. Donald T. Graham, Paul J. Cloke. Principles of Radiological Physics. Churchill Livingstone, 2003.
15. Thomas S. Curry. Christensen',s Physics of Diagnostic Radiology (4th Edition). Lippincott Williams & Wilkins, 1990.
16. Madison. MRI – Perry Sprawls – Medical Physics Publishing. Wisconsin, 2000.
17. Steve Webb. The Physics of Three–Dimensional Radiotherapy. Institute of Physics Publishing, Bristol and Philadelphia, 2002.
18. Radiation oncology physics: A Handbook for teachers and students. IAEA publications, 2005.
19. F. M. Khan. The Physics of Radiation Therapy (3rd Edition), Lippincott Williams and Wilkins, U.S.A., 2003.