BHARATHIAR UNIVERSITY, COIMBATORE

PG DIPLOMA IN IMAGING TECHNOLOGY (AFFILIATED COLLEGES)
(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2007 - 2008 AND ONWARDS)

Syllabus taught during one year course of imaging technology.

SEMESTER-I **TOTAL TEACHING HOURS- 450 HRS**

	MAXIMUM MARKS
Paper-I Basic concept of physics (90 hrs)	25+75
Paper –II Anatomy and Physiology (90 hrs)	25+75
Paper-III Applied imaging technology-I (Physics of diagnostic tools- X-Ray) (90 hrs)	25+75
Paper-IV Physics in Medicine (90 hrs)	25+75
Practical (90 hrs)	

SEMESTER-II **TOTAL TEACHING HOURS: 450 HRS**

Paper- V Applied Imaging technology-II (Physics of MRI and NMR)	25+75
paper-Vi Applied Imaging technology-III (Physics of CT)	25+75
Paper-VII :- Institutional training	100
Paper-VIII:- Practicals	25+75

NOTE:- 25% of the marks is for internal assessment except for institutional training

Pattern :- Semester **No.of Semesters: 2**

SEMESTER I

PAPER-I:-
Basic concept of physics (90 hrs)

Unit-I:- Dosimetry and Radiation Biology

Radiation units:- Exposure; Coulombs/Kg. Air kerma- gray, absorbed dose-gray, equivalent dose- sievert. Effective dose – sievert.

Interaction mechanisms: Ionization, excitation free radicals. Introduction to concept of Linear energy transfer (LET).

Unit-II Interactions:-

Interactions of charged particles, interaction of electromagnetic radiation. Neutron interactions. Introduction to thermography and microwave equipment and interactions. Optical interaction ultra sound interactions.

Unit-III Basic concepts of electromagnetic radiation

Electromagnetic waves, Relationship between frequency and wavelength. The electromagnetic spectrum, sources of electromagnetic radiation. Risks from occupational exposure- public, occupational exposure of pregnant women. Diagnostic reference levels (DRL)

Unit-IV Basics of NMR and MRI

Basic Nuclear Magnetic Resonance (NMR), nuclear magnetic moments effect of external magnetic field. Nuclear precession. Equilibrium magnetization, significance of Radio frequency (RF) pulse (NMR) and microwave (EPR) equipment.. Resonance and larmor frequency. Free induction Decay (FID).

Unit-V

Radiation detectors:, Radiation protection- biological aspects. Measurement of detriment. ICRP frame work of radiological protection.

Paper-II

Anatomy and physiology (90 hrs)

Unit-I

1. The human body as a whole.

Definitions. Subdivision of Anatomy. Terms of location and positions, Fundamental planes. Vertebrate structure of man, Organization of the body cells, Tissues.

II. Anatomy of Nervous system.

Central nervous system: Spinal cord, anatomy

Unit-II

Anatomy of circulatory system

Heart size. Location, Coverings, Chambers. Blood supply, nerve supply, and the blood vessel. Names of arteries and veins.

Anatomy of respiratory system

Organs of respiratory system
Respiratory portions-Pleurae and lungs. Brief knowledge of parts and position.

Unit-III

Anatomy of Digestive system.

Components of digestive system, Mouth, Tongue, Tooth, Salivary glands, Liver, Biliary apparatus, pancreas-position and their brief functions.

Unit-IV
Anatomy of excretory system and reproductive system

Kidneys:- Ureters, Urinary bladder, Urethra
Male reproductive system-Testis, Duct system
Female reproductive system-Ovaries, Duct system and accessory glands

Unit-V
Anatomy of Endocrine system:-

Name of all the glands and their position, hormones and their functions-Pituitary, thyroid, para thyroid, adrenal gland and gonads, islets of pancreas.

Paper-III

Applied imaging technology-I (Physics of diagnostic tools- X-Ray) (90 hrs)

Unit-I

Introduction to diagnostic radiology I and II. Introduction to diagnostic radiology III. Digital Radiology-I. Digital radiology II and III.

Unit-II:- production of X-ray

Bremsstrahlung and characteristic radiation. The X-ray spectrum. The intensity of X-ray Beams. X-ray tubes.

X-ray generators. Transformers, X-ray Generator types. Effect of waveform on Radiation output. Exposure switches and Timing.

Unit-III:- Interactions between X-rays and Matter.

Attenuation. Interaction process. Relative importance of different types of interactions. Scatter radiation. Contrast media. Filtration:- Grids and Air gap technique.

Unit-IV:- Screen/Film systems.

Luminescent screens- General Principles, Absorption of quantum detection efficiency (QDE). Conversion efficiency.

Physical characteristics of X-ray film and film processing. Structure of X-ray film. Latent image formation by light (or) X-rays. Automatic film processing..

Unit-V:- Image quality in Radiology.

Radiographic (or) image contrast. Radiographic Mottle (noise) ,Blur. Modulation transfer function. Geometry of the Radiographic Image. Mammography – an introduction and description.

Paper-IV:-

Physics in medicine (90 hrs)

Unit-I
Nuclear medicine:-

In vitro and in vivo testing, gamma rays for imaging, radio pharmaceuticals:- preparations and quality control, chemistry and radio pharmacology of radio nuclides, gamma camera, SPECT, PET.

Unit-II

Ultrasound in medicine:-

Ultrasound imaging, generation and detection of ultrasound, ultrasound propagation,. choice of frequency, A-scan, B-scan, M-mode imaging and echo cardiography. Use of Doppler techniques for blood flow etc.

Unit-III

Neuroelectrics and Neuromagnetics

Basic electrophysiology, genesis of electric and magnetic signals techniques for measurement and imaging of EEG, ECG,MEG and MCG. Fluoroscopy and image intensifier.

Unit-IV

Bioeffects and safety of

X-ray, NMR ,MRI and Ultrasound

Special procedures: Ivp, Barium studies, Mcu and H.s.g. basic nursing

Unit-V

Terminology :- anatomical terminology, positioning terminology and projection Terminology.

Image sharpness:- Geometric unsharpness, movement unsharpness, absorption unsharpness and photographic unsharpness.

High K.V technique, Magnification.

Practicals (90 hrs) :- Basic observation in the lab and as well as basic quality required To work in the lab

SEMESTER-II (450 hrs)

Paper-V

Applied imaging technology-II (Physics of MRI and NMR)

Unit-I Basic concepts:-

Introduction to MRI and NMR. Physics of proton NMR. Probing chemical structure, chemical shielding (NMR); the g-value (EPR): through-bond J coupling and through - space dipole-dipole coupling (NMR).

Unit-II :- NMR

Chemical shift, Relaxation- general mechanisms. Longitudinal (T_1) relaxation time. Transverse (T_2) relaxation time effect of field in homogeneities. T_2*
Standard sequences; ultra fast sequences

Pulse sequence: Inversion recovery and STIR. Spin- echo. Gradient sequences; MR Angiography.

Unit-III:- MRI

Imaging Techniques: Gradient Magnetic fields. The Fourier transform and The FID. 2D-Fourier transform reconstruction methods. Inter leaved Multislice Imaging. 3D- Fourier Transform reconstruction methods. Fast imaging techniques.

Unit-IV:- MRI-2

Imaging Quality. Effects of flow. Instrumentation. Safety and contra-indications. MRI in practice. One-dimensional imaging: frequency encoding using magnetic field gradients; two-dimensional imaging: phase encoding; slice selection (3D to 2D); gradient echoes.

Unit- V

Introduction to in Vivo MR-Spectroscopy, Single-Voxel MRS. Introduction to spectroscopic Imaging (CSI). Processing MRS data. Flow and Angiography. Advanced pulse sequences and techniques. Clinical applications of MRI.

Paper-VI

Applied Imaging Technology –III (Physics of Computed Tomography)

Unit- I Basic concepts of CT scan

Introduction to CT scan; Computer data; Medical imaging terminology, Principles of CT scan. Stimulation and virtual stimulation. Classical X-ray tomography. Principles of sectional imaging, scanner configurations, mechanical features.

Unit-II:-

CT and conformal planning, hand planning; tissue compensation; algorithms for computing dose distributions in patients for photon and electron beams, including convolution methods and Monte Carlo simulation;

Unit-III

CT- Instrumentation, Imaging processing for computed tomography. Geometry – parallel, fan beam geometry, cone-beam geometry , line integrals and projection datasets. CT- characteristics of common structure.

Unit-IV

Spiral and helical computed Tomography; Multislice spiral computed tomography, 2D Fourier reconstruction, convolution and back projection, design performance of filters in CBP technique, digital filters, CT image display, windowing, CT numbers, angular sampling requeirements.

Unit-V

Radiation dose: dose-spatial resolution- density resolution trade off, partial-volume and beam hardening effects. Clinical application of Computed Tomography and in radiotherapy planning.

Paper VII (Semester I and II)

PRACTICALS

1. **POSITIONING RADIOGRAPHY AND TECHNIQUES**
2. **DARK ROOM TEHNIQUES**
   a. Washing
   b. Developing
   c. Drying
   d. Disposing the waste.
3. **STORING AND RECORD ROOM.**

On lab training for entire semester.

Reference books for PG Diploma in Imaging Technology

Medical Physics Textbooks

1) E. G. A. Aird: *An Introduction to Medical Physics.* (Heineman, 1985).
2) J. L. Ball and A. D. Moore: *Essential Physics for Radiographers* (2nd ed.) (Blackwell Scientific).
3) Brown and Smallwood: *Medical Physics and Physiological Measurement* (Blackwell, 1981).
4) J. R. Cameron and J.G.Skofronick: *Medical Physics* (Wiley International). Recommended for useful in-depth information, images and diagrams.
5) J. S. Carruth and A. L. McKenzie: *Medical Lasers* (Adam Hilger Ltd).
6) J. E. Coggle and G. R. Noakes: *Biological Effects of Radiation* (Wykeham).
7) Alan H. Cromer: *Physics for the Life Sciences* (McGrew Hill Book Co., 1977).
8) T. S. Curry, J. E. Dowdey, and R. C. Murry: *Christensen's Physics of Diagnostic Radiology* (Lea & Febiger, 4th edition 1990). Beautifully clear, non-mathematical description of all the principal medical imaging methods.
9) Damask: *Medical Physics. Vol I Physiological Physics, External Probes* (Academic Press).
10) Damask: *Medical Physics. Vol II External Senses* (Academic Press).
11) Damask and Swenberg: *Medical Physics. Vol III Synapse, Neuron, Brain* (Academic Press).
12) D. Gifford: *Handbook of Physics for Radiologists and Radiographers* (Wiley).
13) G. Hart and F. Armas: *Medical Physics for Advanced Level* (Simon & Schuster, 1992). An up to date book at the right level for A level students. It has an appropriately pitched section on MRI.
14) Hay and Hughes: *First Year Physics for Radiographers* (Bailliere & Tindall, 1983). Gives extra detail on the topics covered, and though it is too detailed for students' requirements, it is useful as a reference book. The work on x-rays is clear and straightforward.
15) D. W. Hill: *Physics Applied to Anaesthesia* (Butterworths).
16) M. Hollins: *Medical Physics* (Macmillan 16-19 Project, 1992). A good students book. Clear and readable and liked by students. The layout is good with photographs and diagrams to illustrate topics. It also has plenty of questions and full, explanatory answers - rather than just numbers - in the back of the book.
17) Johns and Cunningham: *The Physics of Radiology.* The most comprehensive text on this subject. Very expensive but says everything.

18) G. E. Knoll: *Radiation Detection and Measurement.* A more thorough treatment of radioactivity. This may be too detailed but does not assume too much prior knowledge.
19) W. B. Mann, R. L. Ayres, and S. B. Garfinkel: *Radioactivity and its Measurement.* Useful for its treatment of interaction of a, ß and g radiation with matter and detection instrumentation.
20) A. Martin and S. A. Harbison: *An Introduction to Radiation Protection* (Chapman & Hall, 1986). Covers all aspects of Radiation Protection including atomic fundamentals, radiobiology, principles of protection, legislation.
21) Meredith and Massey: *Fundamental Physics of Radiology* (J.Wright & Sons Ltd).
22) Nuffield Chelsea Curriculum Trust: *Radioactivity* (Pupil's book) (Longmans, 1981).
23) R. P. Parker, P. H. Smith, and D. M. Taylor: *Basic Science of Nuclear Medicine.* Covers basic radiation physics and biology, measurement and instrumentation, chemistry, radiopharmacy. A good introduction to physics in nuclear medicine.
24) R. L. Page: *The Physics of Human Movement* (Wheaton).
25) J. A. Pope: *Medical Physics* (Heinemann, 1999). ISBN 0-435-57094-3. Part of Heinemann's range of books for their Advanced Science series. 188 pages long and aimed at the Edexcel syllabus, although it meets the medical imaging requirements of other examination boards. There are five chapters, covering ultrasound, diagnostic x-rays, radioisotopes in diagnosis, magnetic resonance imaging, radiotherapy, and radiological protection. Drafts of these chapters were given to members of this Department to check through and make sure that the information was up-to-date. The book is clear and well set out. To find out more about this book, please visit the Heinemann website.
26) Martin E. Rosenberg: *Studies in Biology No 145 Sound and Hearing* (Edward Arnold, 1982).
27) D. Sumner: *Radiation Risks - An Evaluation* (Tarragon Press).
28) M. K. Sykes, M. D. Vickers, and J. Hull: *Principles of Clinical Measurement* (Blackwell).
29) S. Webb: *The Physics of Medical Imaging.* Covers every imaging modality in considerable detail. Perhaps too mathematical in places.
30) P. N. T. Wells (Ed.): *Scientific Basis of Medical Imaging* (Churchill Livingstone).
31) R. Wilkes: *Principles of Radiological Physics* (Churchill Livingstone, 1987). A more comprehensive treatment of the subject with many mathematical derivations but nevertheless approachable.
32) J. Wilson and J. F. B. Hawkes: *Lasers, Principles & Applications* (Prentice Hall).

Books on specific Medical Physics applications

1. J. O. Rowan: *Physics and the Circulation*

2. R. L. Kathren: *Radiation Protection* (1985). Includes Natural Radiation,properties of ionising radiation, units, dosimetry, biological effects, legislation, instrumentation, design and operation factors. A very useful book which is descriptive rather than mathematical.
3. A. F. McKinlay: *Thermoluminescence Dosimetry* (1981).
4. P. W. Horton: *Radionuclide Techniques in Clinical Investigation* (1982).
5. J. R. Greening*"Fundamentals of Radiation Dosimetry* (1985). This series may be too specialised for an introduction to the subject.
6. S. Webb (Ed), *The Physics of Medical Imaging*, Hilger
7. P.P. Dendy and B Heaton, *Physics of Diagnostic Radiology*, IOPP
also
8. B.H. Brown et. al., *Medical Physics and Biomedical Engineering* IOPP;
9. F. Duck, *Ultrasound in Medicine*, IOPP;
10. E. Krestel, *Imaging Systems for Medical Diagnostics*, Siemens;
Maisey, Britton and Gilday (Eds), *Clinical Nuclear Medicine*, Chapman and Hall;
11. WR Hendee *Radiation Therapy Physics*, Mosby;
12. WR Hedrick, DL Hykes, and DE Starchmann, *Ultrasound Physics and Instrumentation*, Mosby;
13. G. Steele, *Basic Clinical Radiobiology*, Arnold;
14. R. Carlton and A. Adler, *Principles of Radiographic Imaging*, Delmar;
J.R.Cameron and J.G. Skofonick, *Medical Physics*, Wiley;
T.A. Delchar, *Physics in Medical Diagnosis*, Chapman and Hall
15. MH Levitt, *Spin Dynamics: Basic principles of Nuclear Magnetic Resonance Spectroscopy*, Wiley

Prescribed Reference

1. Heggie JCP, Liddell NA & Maher KP, 2001. Applied Imaging Technology, 4th Edition (St Vincent's Hospital: Melbourne)
2. Bushberg JT, Seibert JA, Leidholdt EM & Boone JM, 2002. The Essential Physics of Medical Imaging, 2nd Edition (Lippincott Williams & Wilkins: Philadelphia) - the first chapter of which provides an excellent introduction to the subject

Reference books for Human Anatomy:-

1) Ester., M. Greishcimer. Physiology and Anatomy with practical considerations. J.P Lippin Cott, Philadelphia.

2) William Davis, Understanding Human Anatomy and Physiology. Mc Graw Hill

3) William's (Pter,L) Gray's Anatomy, 38th eds. Chruchill Livingstone, 1995.

4) T.S. Ranganathan, A text book of Human Anatomy

5) Fahana. Human Anatomy (Descriptive and Appl ed) Saunder's & Co, Prism Publishers, Bangalore.

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