NIMS UNIVERSITY, JAIPUR

SYLLABUS

DIPLOMA IN MEDICAL RADIOGRAPHY TECHNOLOGY (D.M.R.T.)

(2 Years Course for 10+2 Stream)

FIRST YEAR

Total Teaching Hours- 450 HRS

Paper	Subject	Hours	Maximum Marks
I	➢ Concept of Physics related of Medicine. ➢ Care of Maintenance of equipment.	90	25+75
II	Anatomy and Physiology	90	25+75
III	Applied Imaging Technology –I (Physics of diagnostic tools X-Ray)	90	25+75
IV	Safe Injection (First Aid)	90	25+75
	Practicals	90	25+75

SECOND YEAR

Total Teaching Hours- 450 HRS

Paper	Subject	Hours	Maximum Marks
V	Radiographic Photography and Dark room Techniques	90	25+75
VI	➢ Contract media, Anatomical terminology for positioning of patients, special techniques in Radiography. ➢ Geometric Unsharpness, movement unsharpness, absorption unsharpness, photographic unsharpness	90	25+75
VII	1. Applied imaging technology –II (Physics of MRI and NMR). 2. Applied imaging technology –III (Physics of CT).	90	25+75
VIII	Institutional training	90	100
	Practicals	90	25+75

Note: - 25 % of the marks are for internal assessment except for institutional training.

FIRST YEAR

Paper I

CONCEPT OF PHYSICS RELATED TO MEDICINE

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 electromagnetic radiation. Risks from occupational exposure- public, occupational exposure of pregnant women. Diagnostic reference levels (DRL)

UNIT-V 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 OIMR) 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.

UNIT-I
Nuclear medicine:-
In vitro and in vivo testing, gamma rays for irnaging, radio pharmaceuticals:- preparations and quality cotltrol, chemistry and radio pharntacology of radionuclides,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 inraging 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-EEG, ECG,MEG and MCG. Fluoroscopy and image intensifier

UNIT-IV
Bioeffects and safety of:-
X-ray, NMR, and MR [and Ultrasound Special procedures: lvp, Barium studies, Mcu and H.s.g. basic nursing.

PAPER II

ANATOMY AND PHYSIOLOGY

UNIT-I

I. The Human Body as a whole:-

Definitions. Subdivision of Anatomy. Terns' 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 TECHNOLOGV-L (PHYSICS OF DIAGNOSFIC TOOLS- X-RAY)

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-ray 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: SAFE INJECTION

UNIT-I

Registration of participants for the model injection centres.

UNIT-II

Rationale for model injection centers program: (i) Magnitude of Injection; (ii) Safety of Injection; (iii) Injection related waste and its disposal; (iv) Rationale use of Injection; (v) What should be done; (vi) Model Injection centres; Specific Objectives.

UNIT-III

Teaching of safe injection: (i) What is a safe injection; (ii) What is safe injection technique; (iii) Steps involved in giving safe injection.

A preparing to give injection: (i) Assemble the necessary equipment; (ii) Wash hands; (iii) Wear gloves.

Drawing up medication: (i) Cutting open a glass Ampoule; (ii) Drawing medication/ Vaccine with AD syringe; (iii) Drawing medication from a vial with regular plastic syringe.

- Recapping needles not recommended
- Single handed method for recapping needles

Common routes for giving injections and locating the injection sites: (i) Injection routes; (ii) Sites for intramuscular injection; (iii) Sites for intramuscular injection; (iv) Sites for intradermal and subcutaneous injection.

Preparing skin – Giving the injection: (i) Intradermal injection; (ii) Subcutaneous injection; (iii) Intramuscular injection

Special things to be kept in mind for an Immunization session.

Common errors made while giving injection.

Assessment of injection practices data and unsafe practices.

Errors to be avoided while giving an injection.

UNIT-IV

Handling and disposal of injection related waste: (i) Autoclave; (ii) Biomedical waste; (iii) Incineration; (iv) Needle stick injury; (v) Recycle; (vi) Re-use; (vii) Terminal disposal of waste.

UNIT-V: Handling injection waste

A. Steps for handling injection waste after giving injection
    a. Disposal of injection. Related wastes at the health facility.
    b. Steps of disposal injection related waste.
B. Handling of waste containers
C. Terminal disposal of injection related waste
D. Color-coding and types of container for disposal at bio-medical wastes.
E. The centre Pollution Control Board and the Ministry of Health & Family Welfare on handle of injection related waste at the outreach level/ outside District Hospital or CHCs and PHC etc.
F. The disposal of bio-medical waste (BMW) generated within tertiary cure hospital/ District Hospitals/ CHCs/ PHCs etc.
G. The containers containing and syringes needles and broken vials to the common bio-medical waste treatment facilities.

UNIT-VI

- Setting up at a model injection centre
- Setting up a model injection centre at your health faculty

1. Basic elements of a model injection centre
    a. Well equipped
    b. Safe
    c. Efficient
    d. Convenient
    e. Hygienic
2. Spacing in the injection room
3. Layout at the model injection centre
4. Adequate supply of injection equipments
5. List of essential equipment for an mechanism
6. Injection tray
7. Waste disposal mechanism
8. Emergency kit
9. Contents of emergency kit
10. First aid box
11. Check the oxygen cylinder daily for proper functioning

UNIT-VII

Rational use of injections.

1. Irrational use of injections
2. Need for rational use of injections
3. What is irrational use of injections
4. Common examples of irrational use of injections
5. Are injections were effective and faster acting than oral medication
6. If oral medication is as effective as injections then why are injectable medications prescribed
7. Problems in the use of injections
    a. When to inject
    b. When not to inject

UNIT-VIII

Technique of safe injection.

1. What is a safe injection (WHO)

First Aid

Shock, convulsion, asphyxia, artificial respiration, administration of oxygen, burns and scalds, electric shock and burns, wound, hemorrhage, pressure points, tourniquet, injuries to bones, joints and muscles, dressing of bandages, plaster of paris technique, splints, drug reaction, poisons, basic nursing.

Drug Department: Storage labeling, checking, regulation regarding dangerous drugs, units of measurement.

Medical Ethics: Ethical laws and professional etiquette as applied to members of profession associated with medicine.

Nursing and Handling of Patients: Hospital and departmental procedure, Hospital staffing and organization, records and departmental statistics, medico legal aspects, appointments, stock taking and stock keeping.
Care of patients: Reception, elementary hygiene.

Nursing Care: Temperature, pulses and respiration, application of sterile dressings.

Preparation of patients for general X-ray examination: Departmental instructions to out patients or ward staff, instructions for various special investigations, nursing care before and after special X-ray, drug allergy.

Principles of Asepsis: Methods of sterilization, care and identification of instruments, setting of trays and trolleys, elementary operating theatre procedure.

PAPER V

RADIOGRAPHIC PHOTOGRAPHY AND DARK ROOM TECHNIQUE

X-ray materials: Types of emulsion – characteristic and control, screen and non-screen films, dental films, X-ray paper under and over exposure, speed contrast.

Intensifying screens: Fluorescence, application of fluorescence in Radiography, type of intensifying screens, intensifying factors, cleaning and general care of screen – after glow.

X-ray cassettes: Testing and proving good screen contract, general care.

X-ray developers: Characteristics, detail and contrast freedom from chemical fog and staining function and constituent of developer, standardization by time and temperatire, exhaustion of developer, replenishers.

Types: Powder and liquid solution, medium and high contrast developer, ultra rapid development methods, automatic processing.

X-ray fixers and fixing: Fixing agents, acid and preservative in fixer, inclusion of hadener, time of fixation, silver recovery.

Rinsing, washing and drying: Object, methods employed, method of drying films.

Processing: Preparation of solution, suitable water supply, nature of mixing vessels, order mixing solutions, filtrations, making of stock solutions, storage of dry chemicals, and storage of solution.

Processing apparatus: Processing units, hangers, care of hangers, refrigeration and use of ice.

Operation theatre processing: Dish units.

Technical and processing faults: Chemical reduction.

Chemistry and characteristics of Farmer's reducer, local and general application.

X-ray Dark Room : Size, light proof entrancer, hatches, construction of walls for protection against chemicals and radiation, ceiling, colour schemes, water proofing of floors, loading bench design, disposition of processing and necessary equipment for efficient working, arrangement of drying cabinets in dark room or in adjacent rooms, dark room illumination and testing for safety ventilation.

The Radiographic Image : Radiographic factors affecting image contrast and sharpness, vriation in exposure time in accordance with quality of radiation filters, distance, intensifying screens, grids, film speed, developer and development.

Presentation of Radiograph: Identification of film, aspect for direct and stereo (univeraprismatic) viewing, mounting dental films.

Accessories : Viewing boxes, spot light, illuminators, projectors and viewing screens for miniature and cine radiography, magnifiers, film identification, lead letters and numbers, actinic markers, embossing machine, film trimmers, corner cutters, dental mounts and cutter, filling units.

PAPER VI

CONTRAST MEDIA

Barium preparation, Iodine preparation, Air- Oxygen.

Skeletal system: Upper linmb, lower limb, shoulder, girdle and thorax, pleura, diaphragmatic excursion, mediastinum bronchography, artificial pheumothorax.

Genioto-urinary system: Straight X-ray of abodomen, pyelegraphy, cystography, urethrogrphy, gas insufflation, pneumo-peritonium.

Obstetrics and Gynecology: Radiation protection, pregnancy, pelvimetry, hystero salpinogagraphy, placentographyy.

Central nervous system: Routine and special projections of skull, ventriculogrphy and encephalography, cerebral angiography, myelogrph.

Alimentary system: Barium suspension, Barium meal and follow through Barium emena.

Billary system: Cholrcystography, Oral and IV Choangiography – Direct and indirect.

Liver and Spleen: Spleno portal venography.

Salivary gland: Sialography, Arthography, singraphy, lu\ynmphangiography, operation theatre technique and ward radiography, stereoscopy. Magnification, high and low KV technique and Mammography.

SECOND YEAR
PAPER VII

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 (Tr) relaxation time. Transverse (T2) 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
fields. The Fourier transform and The FID. 2D- Fourier transform reconstruction methods. Imaging Techniques: Gradient Magnetic 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. Introductio4 to spectroscopic Imaging (CSI) Processing MRS data. Flow and Angiography. Advanced pulse sequences and techniques. Clinical applications of MRI.

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 photon and electron beams, including convolution methods and Monte Carlo simulation; computing dose distributions in patients for

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, windou'ing,CT numbers, angular sampling requirements.

UNIT-V

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

PRACTICALS

1. Positioning Radiography and Techniques.
2. Dark Room Techniques.
   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 & Febier, 4th edition 1990). Beautifully clear, non-mathematical description of all 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 anesthesia (Butterworths).
16. M. Hollins: Medical Physics (Machmillan 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 topic. 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: Radiotion 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, b and g radiation with matter and detection instrumentation.

20. A. Martin and S. A. Harbison: An introduction to radiation protection (chapman 7 Hall, 1986). Covers all aspects of radiation protection including atomic fundamentals, radiology, 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 sciences 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 Advance Sciences series. 188 pages long and aimed at the Edaxcel 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 boom is clear and well set out. To find out more about this book, 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. Well (Ed.):- Scientific Basic 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 ionizing radiation, units, dosimetry, niological effects, and 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: Radioniclide techniques in Clinical Investigation (1982).
5. J. R. Greening "Fundamentals of Radiation Dosimetry (1985). This series may be too specialized 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. Dusk, ultrasound in Medicine, IOPP.
10. E. Krestel, Imaging System 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 Strachmann, Ultrasound Physics and Instrumentation, Mosby.
13. G. Steel, 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.