

SCHOOL OF RADIOGRAPHY

MINISTRY OF HEALTH

SRI LANKA

CURRICULUM

FOR

DIPLOMA IN

DIAGNOSTIC RADIOGRAPHY /

RADIOTHERAPY

Prepared in 1989

Introduction

Radiographers are integral members of a team dedicated to providing patient care. Their primary role is to perform the technical procedures in producing radiographic examinations for the diagnosis of disease and injuries or performing Radio-therapy treatment procedures for Cancer patients . Precision, compassion, and a willingness to care for the sick and injured are prerequisites for entering the profession.

This syllabus is based on the syllabus for higher diploma in radiography & radiotherapy of the College of Radiographers, United Kingdom offered in 1982. It is to be covered in two years full time without vacation.

The curriculum is primarily a discipline based theoretical teaching and practical training programme. But it is always encouraged to integrate academic study with the clinical practice.

The three basic subjects; namely, Physics, Anatomy & Physiology, and, Hospital practice & Care of patient are taught commonly for both Diagnostic and Therapeutic Radiography fields during the First year. Some radiography related pathology and Medical terminology also is included. The students are sent for practical work in the diagnostic and therapeutic departments separately. The students are required to perform diagnostic or therapeutic procedures with the aid of the senior radiographers and under supervision at early stages, and, unaided but with close supervision during last stages of practical training.

The students are separated to their relevant fields during the second year. The theory subjects, mainly three for each field, are different for the two fields during the second year. More time is allocated for clinical experience during the second year. The students are placed on a Rota basis to gain experience in different types of diagnostic and therapeutic procedures relatively.

The practical work is continually assessed and the students are required to complete a record book.

The evaluation is by the end of the year examinations. The examinations consist of written papers practical component and an oral examination.

Students who complete the Program will be awarded a Diploma in Diagnostic Radiography OR Radiotherapy by the Ministry of Health and will be eligible to register as radiographers at the Medical College Council and at the Sri Lanka Medical Council, which is the legal requirement to practice within Sri Lanka.

**Mission Statement**

The Radiography Program at The Sri Lanka School of Radiography will provide students with state-of-the-art imaging facilities at The National Hospital of Sri Lanka and a learning environment that fosters the development of clinical and patient care skills which are necessary to competently function as entry-level radiographers. The curriculum will help the student radiographers to understand and practice the Patients First philosophy and will allow them to work collaboratively with other healthcare and imaging professionals and acquire problem-solving and critical thinking skills necessary for successful employment in the relevant field.

**Minimum requirement for entry for the course of training in Radiography**

1. Pass in six subjects at General Certificate of Education Ordinary Level examination

conducted by the Examination Department of the Government of Sri Lanka with credits in ,

(i) Sinhala (language)

(ii) Mathematics

(iii) Biology/Physics/Chemistry/General Science

(iv)one other subject and a pass in English.

2. Pass in the Advanced Level Examination in three science subjects including

 a **credit or higher grade in** **Physics**.

**Goals & Student Learning Outcomes**

In support of the program's mission statement, the following have been developed.

Upon completion of this Radiography/Radiotherapy program the students will have successfully completed a number of goals and student learning outcomes.

**Goal 1: The students will operate as entry-level radiographers**

Learning Outcomes:

* Students will prepare and position the patients for specific diagnostic/therapeutic procedures
* Students will select appropriate technical factors
* Students will demonstrate appropriate radiation safety practices.

**Goal 2: The students will employ effective communication skills**

Learning Outcomes:

* Students will demonstrate effective, age-specific oral communication skills.
* Students will demonstrate effective written communication skills

**Goal 3: The students will utilize critical thinking and problem-solving skills**

Learning Outcomes:

* Students will assess patient condition and modify procedures accordingly.
* Students will evaluate images for diagnostic quality & formulate necessary improvements

**Goal 4: The students will demonstrate high standards of patient care & professional practice**

Learning Outcomes:

* Students will be knowledgeable of the importance of professional organizations
* Students will display professionalism in the clinical environment
* Students will demonstrate a commitment to life-long learning

**Goal 5: The program will meet the needs of the community by producing qualified, competent radiographers**

Learning Outcomes:

* Students enrolling in the program will complete the program
* Successful Students seeking employment will be employed in the field
* Students will be satisfied with the program
* Employers will be satisfied with the quality of Radiographers

Outline of the syllabus

 **First year :- Common for both Diagnostic & Therapeutic fields**

**Subjects & Number of hours**

* Anatomy , Physiology & Pathology – 120 hours (including demonstrations)
* Physics
* General Physics - 150 hours (including practical demonstrations)
* Radiation Physics - 80 hours (including practical demonstrations)
* Hospital Practice, Care of patient

 & Medical terminology - 90 hours (including visits to wards/OT/CSSD)

* **Clinical Practice** - 1120 Hours

**Second year**

1. **Diagnostic Radiography**

**Subjects & Number of hours**

* Equipment for Diagnostic Radiography / Imaging equipment – 100 hours
* Radiographic Imaging / Radiographic Photography – 100 hours
* Radiographic Technique – 200 hours
	+ General radiography
	+ Contrast Radiography / Special examinations
* Clinical practice - 1160 hours
1. **Radiotherapy (Therapeutic radiography)**
* Radiotherapy Physics & Equipment - 100 hours
* Principles of radiotherapy & Oncology - 100 hours
* Radiotherapy Technique - 100 hours

* Clinical practice - 1260 Hours

**Teaching Staff:**

Anatomy & Physiology lecturers – from College of medicine or specially

 appointed for teaching at Education

 Training & Research Unit.

Physics lecturers - from Department of Physics, University of

 Colombo

Medical Physicists - From Cancer Hospital, Maharagama

Radiography Tutors - Full time or Part time

Radiologist - From College of Radiologists

Radiotherapist & Oncologist - From Cancer Hospital, Maharagama

Senior Radiographers - From National Hospital, Colombo & Cancer

 Hospital Maharagama

**Assessment:** Summative : By Year end examinations on all subjects

 **First Year**

Three hour written question papers including MCQ, and Short answer type

 questions

 **Second Year**

Three hour written question papers including MCQ, and Short answer type

questions

Practical examination

Viva Voce

 **Pass mark** :- 50% on all subjects.

**Training & Exam Regulations**

**Eligibility** :- Should have not less than 80% attendance for all lectures and

 practical sessions.

**Pass** :- Should obtain 50% or more in all subjects

**Referred** :- A student failed in **one** subject out of three at the first year examination

 OR

 one or two subjects out of five at the final examination is considered to have

 referred in that subject/s and can re sit only that subject/s in an other attempt

 to complete and secure a pass.

**Fail** :- A student who fails in two or more subjects at the first year examination and

 three or more at the final examination is considered to have failed the whole

 examination.

**Repeat examinations & Number of attempts**:-

 Two repeat examinations are held at three months interval for first year and the

 final examinations. A student who fails to complete any examination in the three

 attempts are discontinued from the programme.

The student who fails or referred in first year examination at the first and the second attempt is permitted to continue the studies in the second year and sit for the repeat examinations.

The Syllabus

CONTENTS

 Page

1. Physics
2. Care of the Patient and Hospital Practice
3. Anatomy and Physiology and Pathology
4. Equipment for Diagnostic Radiography
5. Radiographic Photography and Imaging Processes
6. Radiographic Technique
7. Radiotherapy Physics and Equipment
8. Principles of Radiotherapy and Oncology
9. Radiotherapy Technique
10. Suggested Reference Books
11. General Classification
12. Training and Examination Regulations

PHYSICS

CONTENTS

Aims and Objectives

Mathematics Relevant to Radiography. Structure of Matter. Basic Physics. Electrostatics

Current Electricity. Capacitors. Magnetism. Some Consequences of Electron Flow.

Electromagnetic Induction. Principle and Construction of a Moving Coil Meter

Some Aspects of A.C. The Transformer. The Concept of Energy

Electromagnetic Radiation. The Atom Radioactivity

Principles of Radionuclide Imaging X-ray Production

X-ray Interaction with Matter X-ray Measurements. The X-ray Circuit

Control of the Tube Current. Rectification. X-ray Tubes Shockproofing

Fuses and Circuit Breakers. Electrical Hazards. Principles of Diagnostic Ultrasound Radiation Protection

Personnel Monitoring

PHYSICS

**Minimum number of Teaching Hours 230**

AIMS AND OBJECTIVES

Students shall be able to define the laws embodied in this syllabus and apply the principles to other subjects and radiodiagnostic/radiotherapeutic equipment in particular.

Where it is appropriate students shall be able to illustrate statements graphically or by the use of simple diagrams.

Students shall be able to perform calculations and solve problems using simple mathematical formulae working with the International System of Units (S.I.). Students shall be able to determine the relationships between S.I. and other units in clinical use.

Students shall be able to express mathematically the relationships encountered in General and RadiationPhysics and apply these relationships where relevant to other subjects.

For the Guidance of Tutors:

Theory should be continually related to practical radiography, supplemented where possible with practical experiments in which the students should actively participate.

Practical work has been listed opposite appropriate items in the syllabus.

**General Physics**

**Mathematics Relevant to radiography**

Arithmetic principles, Procedures and conventions

Simple proportion.

Inverse proportion.

Use ofindices, roots and logarithms.

Graphical representation of data (using linear and non-linear scales).

Interpolation of graphs (interpolation and extrapolation).

Simple trigonometry.

Implications of the exponential law.

Inverse square relationships.

Use of constants in equations and their implications.

Errors and the relative importance.

Use of elementary statistical principles.

Use of electronic calculator.

**STRUCTURE OF MATTER**

Elements, compounds, atoms, molecules, solids, liquids, gases.

**BASIC PHYSICS**

Velocity and acceleration.

Mass and inertia.

Kinetic and potential energy.

Force, power, work and the units in which they are measured.

**ELECTROSTATICS**

Simple model of the atom in terms of electric charge.

Properties of electric charges.

Separation of charge.

Laws of electric force.

Electric potential.

Potential difference.

Electric fields and interaction between fields.

Electromotive force.

**CURRENT ELECTRICITY**

Current as a flow of electrons (not necessarily in a wire)

Conductivity in terms of availability of “free” electrons in the material.

Simple band theory.

Ohm ’s law as an expression of the relationships between electron flow in a

conductor and the applied potential difference.

Variation of resistance with temperature.

Resistor arrangements.

Relations between current, potential difference and energy.

Shunts.

Heating effect of an electric current.

**CAPACITORS**

Physical factors governing capacitance.

AK

C α ---------

 d

Q = VC

Charge stored in a capacitor.

Charge and discharge mechanisms.

Rate of charge and discharge; time constant.

Capacitor arrangements.

**MAGNETISM**

Magnets and poles.

The process of magnetization.

Magnetic fields and interactions between fields.

Magnetic fields around currents.

Force on a current in a magnetic field.

The motor principle.

**SOME CONSEQUENCES OF ELECTRON FLOW**

Effect of resistance to electron flow.

Heating effect.

Magnetic effect and hysteresis.

**ELECROMAGNETIC INDUCTION**

Effect on a conductor of a changing magnetic field.

Mutual and self inductance.

Laws of electromagnetic induction.

Generation of a.c.

Emf induced into a closed circuit by means of a changing magnetic

field.

Demonstration of mutual inductance with and without an iron core.

**PRINCIPLE AND CONSTRUCTION OF A MOVING COIL METER**

Ammeter, voltmeter conversion.

**SOME ASPECTS OF A.C.**

R.M.S. peak and average values.

Measurement of a.c.

**THE TRANSFORMER**

The principle and construction of the transformer

Copper losses.

Iron losses.

Regulation.

Rating.

Efficiency.

**CONCEPTS OF ENERGY**

Forms of energy.

The principle of conservation of energy.

Heat and temperature. (It is of the greatest importance that the student

can differentiate between HEAT and TEMPERA TURE.)

Heat transfer by the processes of conduction.

Heat transfer by the processes of convection.

Heat transfer by the processes of radiation.

Effect of heat on a metal in terms of thermal expansion.

**RADIATION PHYSICS**

**ELECTROMAGNETIC RADIATION**

Manifestation and properties

Processes resulting in the production of electromagnetic radiation.

Characteristics of wave and quantum method of energy transfer.

The duality principle.

Electromagnetic spectrum.

Quality and intensity. (It is important that students be able to

understand the MEANING of the terms quality and intensity.)

Continuous spectrum of white light. Demonstration of the continuous spectrum and line spectra of light

Construction and principle of operation of the photoelectric cell.

**THE ATOM**

Structure of the atom.

Atomic number

Mass number. .

Modification of atomic structure Without disturbing electrical neutrality

(preparatory to study of semiconductors). Modification of the atomic structure affecting total electrical neutrality i.e. ionisation (friction,thermionic emission, photoelectric emission, field emission).

Fluorescence and thermoluminescence.

**Band structure of electron energy levels in solids.**

Electron traps.

Relevance to semi-conductors.

Relevance to phosphorescence.

Relevance to fluorescence.

Relevance to thermoluminescence.

Relevance to line spectral emission.

**RADIOACTIVITY**

Nuclear structure and radioactivity. (Natural and induced).

Radioactive decay. Half life

Characteristics of radioactive emissions.

Units of activity. Definition of Becquerel.

Methods of detection of nuclear radiations. \_

Precautions in the handling of sealed and unsealed radionuclides.

**X-RAY PRODUCTION**

Bremsstrahlung and characteristic radiation.

(Demonstration of the effects of varying factors (kVp, mA filtration and distance)on the intensity and quality of an X-ray beam

Primary and leakage (stray) radiation.

Intensity and quality.

Effects of variation of tube voltage, current, generation of H.T. waveformand change of target material.

Intensity/effective energy distribution curves and the significance of themain features of such a curve, i.e. maximum energy (minimumwavelength), characteristic peaks.

**X-RAY INTERACTION WITH MATTER**

Exponential attenuation of monochromatic radiations

Attenuation (Absorption and scatter)

Attenuation and the inverse square law.

Photoelectric effect.

Scatter - Compton (modified) and classical (unmodified).

The significance of photon energy (keV), atomic number and density of the absorber (on these interactions). Dominant interaction in tissuesat different photon energies.

Effects of filtration on the X-ray beam.

The effect of absorption and scatter on

a) patient (and staff) dose

b) radiographic contrast and tissue differentiation.

Further aspects of the absorption due to thepolychromatic nature of the X-ray spectrum.

**X-RAY MEASUREMENTS**

Effect of X-ray absorption which may be used for measurement.

Units of exposure and absorbed dose to include definition of theGray.

X-ray quality: its specification and measurement.

Film badge -see personnel monitoring.

Principles of ionisation and other dose meters and dose rate meters.

Use of simple equipment e.g. dose and dose rate meters.

Use of aluminium step wedge to compare thequality of radiation produced by different X-ray units at thesame kV values.

Experiments to demonstrate the half value thickness for a beamof radiation.

**X-RAY TUBES**

Construction of fixed anode X-ray tubes (inserts and shields).

Filament design: anode design (fixed anode).

Line focus principle. Methods of cooling.

Construction of simple rotating anode tube and the difference in structure between it and the stationary anode type.

**SHOCKPROOFING**

Earthing and non-conducting metal parts of equipment e.g\_ X-ray table, tube stand etc. and the earthing of the X-ray tube casing, metal braid surrounding high tension cables and high tension transformer tank.

Function and construction of high tension cables.

**FUSES AN CIRCUIT BREAKERS**

The function of fuses and circuit breakers and their position in the circuit.

The importance of using the correct gauge of fuse wire should be emphasised.

Inspection of different types of circuit breakers (as found on mains switches and mobile units for instance).

**ELECTRICAL HAZARDS**

**RADIATION PROTECTION**

***(Students should be conversant with the general principles of protection from the beginning of their training.***

***Radiation protection as a topic has been left to the end of the syllabus for formal teaching so that students can relate the various terms, effects etc. they are dealing with in practice).***

Current Codes of Practice.

*(Each student should read the relevant parts of the current legislativedocuments such as “Code of Practice for the Protection of Persons against Ionizing Radiations Arising from Medical and Dental Use” and local departmental rules, and state the significance of these regulations so far as patients, staff and members of the public are concerned).*

Genetic and somatic effects of ionizing radiation

Significance of the annual limits to designated persons, non-designated members of staff and the general public.

Legal responsibilities of the radiographer.

Precautions in the handling of sealed and unsealed sources.

**PERSONNEL MONITORING**

Unit of dose equivalent

Photographic film as a dose meter.

Construction and function of the monitoring badge.

Thermo luminescent materials as dose meters.

Other dose meters.

Procedures for radiation surveys.

Protection materials (including building materials).

Room design, tube and room protection.

Departmental surveys.

Implications of Health and Safety at Work Act and otherrelevant legislative documents.

**Care of The Patient & Hospital Practice & Medical Terminology**

**CONTENTS**

Aims and Objectives

Nursing. General Care of the Patient. Professional Attitude of the Radiographer .

Hygiene, Infection and Principles of Asepsis. Care of the Patient

Nursing Accessories. Moving and Lifting. Drugs.

Hospital Practice. The Radiographer in the Hospital Team. Design of Radiodiagnostic or

Radiotherapy Departments. Organization of Radiodiagnostic or Radiotherapy Departments.

Medico-Legal Considerations

Medical Terminology

**CARE OF THE PATIENT AND HOSPITAL PRACTICE**

**Minimum number of teaching hours 90**

**AIMS**

There are two main aims in this syllabus:-

(l) to enable the radiographer to provide safe-E for the needs and welfare of the patient.

(2) to make the radiographer an efficient member of the hospital team.

**OBJECTIVES**

The student should be able to demonstrate orally and in writing:

* an understanding of the various procedures for the care of the patient in the situations listed in the following pages.
* a knowledge of the personal qualities which contribute to a successful working relationship in the hospital team, and with patients and relatives.
* a knowledge of the causes of infection and the practical implications for the hospital procedure.
* a knowledge of the working principles of nursing accessories in common use.
* a knowledge of the principles of classification, custody and administration of drugs, particularly in relation to use in the department or to patients under investigation or treatment.
* a knowledge of the departmental design and organizational requirements necessary for the practical running of the department.
* sufficient knowledge of the working administration of the hospital to show how the radiographer integrates into the hospital team.
* a clear understanding of ethical and legal responsibilities in the profession.

It is important that the practical aspects of this subject are emphasized at all times. Some sections will be best taught in theory before practical application is necessary Y whilst others will be better understood after the student has had experience of dealing with patients. Class demonstrations and practice sessions should be arranged when possible.

**GENERAL CARE OF THE PATIENT**

First contact with patients in the department.

General observations of all patients, in order to understand significances of signs and symptoms noted, and take appropriate action.

Temperature, pulse, respiration and blood pressure - normal values and methods of taking and recording them; common clinical abnormalities leading to physiological changes.

The reasons for, methods and significance of routine clinical investigations - e.g. full blood picture; cerebro-spinal fluid; biopsies.

The administration of bedpans, urinals, vomit bowls, and sputum pots.

In-patient care - the ward situation; - to give a general understanding of the function of the whole hospital team and its twenty-four hour care of patients (when possible to see any special procedures carried out on the wards).

Emergency care of the patient - to apply the general principles of first aid as recommended by the Red Cross or St. John Ambulance Brigade, and to take appropriate action in general situations, and in specific emergencies which may occur in hospital and in the department.

The psychology of the sick patient - sufficient to enable students to appreciate the behaviour of patients. (It is recommended that this should not be taught by a psychologist, but preferably by an experienced radiographer).

Special practical advice should be given regarding the management of children, the elderly, the disabled, potentially violent patients, and patients in terminal stages of disease.

Consideration should also be given to approach to, communication with, and general care of patients’ relatives.

**PROFESSIONAL ATTITUDE OF THE RADIOGRAPHER**

Appearance and personal hygiene; behaviour towards staff and colleagues; manner with patients and relatives.

Acceptance of responsibility for the care of the patient.

**HYGIENE, INFECTION AND PRINCIPLES OF ASPSIS**

Causes of infection, its process, methods of spread and practical implications.

Procedures in the event of notable diseases.

Basic hygiene relative to staff, patients and environment.

Consideration of specific situations such as an operating theatre, minor operations area, intensive care unit and other areas where special hygiene precautions are required.

Knowledge of methods of sterilization. Function of Central Sterile Supply Department.

(The aim of this section should be to give an overall understanding of the complete situation so that a student could, for example, apply the principles to the procedure for an intravenous injection or the application of a simple sterile dressing.)

**CARE OF THE PATIENT**

Observation and care of the unconscious patient.

Barrier and reverse barrier nursing.

Immediate post-operative care.

**Care of the patient** - before, during and after diagnostic and/ or radiotherapeutic procedures.

-before, during and after anaesthesia.

- with a tracheostomy, colostomy, diabetes mellitus, radioactive sources in situ,requiring dialysis etc.

- during catheterization or intubation.

- during enema and colon washout procedures.

-in general abdominal preparation.

(This section should be read in conjunction with the technique syllabus, where the care of the patient inspecific investigations or treatments is covered.)

**Nursing accessories**

Identification, care and use of equipment and instruments in general use in the department.

The resuscitation team and the use of resuscitation equipment.

Use, care and function of suction apparatus.

Administration of oxygen.

**MOVING AND LIFTING**

Procedures related to moving patients of varying abilities, on and off chairs, tables, stretchers, bedpans, and the care and safety of the patients during these procedures.

Correct methods and hazards of lifting and maneuvering patients.

(This section should be considered from the point of View of the “lifter” and the “lifted”.)

**DRUGS**

Methods of administration.

Reactions to drugs, allergic reactions especially in connection with the use of radiological contrast agents

Recognition of these reactions and appropriate action to be taken.

Consideration of Various categories of drugs and the regulations relating to their use and storage.

**HOSPITAL PRACTICE**

**THE RADIOGRAPHER I N THE HOSPITAL TEAM**

Principles of Health Service Administrative Structure in Sri Lanka.

Hospital staffing an organization.

The radiographer and radiographic professional organizations.

**DESIGN OF RADIODIAGNOSTIC OR RADIOTHERAPY DEPARTMENTS**

Consideration of aspects of their design which affect patient care.

Facilities, amenities, and safety factors to be included.

**ORGANISATION OF RADIODIAGNOSTIC OR RADIOTHERAPY DEPARTMENTS**

Staff requirements for the practical running of the department for normal working and major incident occurrences.

Appointments systems.

Records relating to patients and departmental statistics.

Stock-taking, and stock-keeping relative to patient care.

Economical use of resources.

**MEDICO-LEGAL CONSIDERATIONS**

Ethical considerations; legal responsibilities and liabilities.

Appropriate action in the event of accidents to patients or staff on hospital premises, examination or

treatment becoming the subject of legal proceedings.

Medical ethics relating to the confidential nature of patients’ information.

Safety legislation.

**MEICAL TERMINOLOGY**

Understanding medical terms

Composition of the medical terms

Prefixes

Suffixes

Roots & Combining forms

Terms related to body systems

**ANATOMY & PHYSIOLOGY & PATHOLOGY**

**CONTENTS**

Introduction

Aims and Objectives .

General Topics

Cells and Tissues

Pathological Processes

The Locomotor System

The Cardiovascular System

The Lymphatic and Reticulo-Endothelial Systems

The Respiratory System

The Digestive System

The Urinary System

The Reproductive Systems

The Nervous System

The Endocrine System

Special Sense Organs

**ANATOMY & PHYSIOLOGY & PATHOLOGY**

**Minimum Number of Teaching Hours 120 Including Tutorials**

**INTRODUCTION**

A knowledge of Anatomy and Physiology is probably the main foundation upon which skilful practical radiography is based.

The inclusion of Pathology as a subject in this syllabus indicates that radiographers are concerned not only with normal anatomy and physiology, but conduct their work in connection with the detection or treatment of disease.

The usual systematic method of learning these subjects is followed in the layout of this syllabus, but a complementary regional approach will assist, for example, the students’ comprehension of radiographic appearances and the complications surrounding the irradiation of specific internal structures.

The facility with which students will learn the various topics in this syllabus may be increased to an important degree by the topics being related, as they are covered, to the students’ practical radiographic work. Teachers are encouraged to emphasize this relationship.

**OBJECTIVES**

Candidates will be able to:

l. Use correct anatomical and physiological terminology.

2. Draw reasonably detailed diagrams of structures, processes and body sections.

3. Provide brief annotations of the nature and causes of disease and abnormalities of

 each system of the body.

4. Relate the basic aspects of pathology to modifications in body function.

5. Classify joints, list bones involved, ligaments, intracapsular structures, blood and

 nerve supply, venous and lymph drainage, functional aspects, associated relations

 and bursae.

6. Describe the attachments, actions and nerve supply of the principal muscles of the

 body.

7. Define each organ, provide a general outline of each, giving shape, size, surfaces,

 situation, colour and consistency. In addition, they will be able to describe the

 relations, blood and nerve supply, venous and lymph drainage of each organ and

 include brief reference to histology, embryology and describe the functional aspects

 of such vessels.

8. Describe the origin, course, termination, relations and branches of principal vessels

 and nerves of the body.

9. Appreciate the differential absorption of radiation by body tissues relative to

 imaging and radiotherapy.

10. Describe the effect of ionizing radiations on body tissues.

11. Define medical terms used with reference to commonly encountered pathological

 conditions. In addition, candidates should be able to make simple relevant

 statements about the nature and causes of such conditions and relate their basic

 aspects to modification in body functions.

12. Describe anatomical structures and physiological processes investigated by

 radionuclides.

13. Describe anatomical structures and physiological processes investigated by

 ultrasonic techniques.

**GENERAL TOPICS**

1. TERMINOLOGY

Students will be required to demonstrate knowledge of appropriate and accurate terms, when describing the various features of anatomy, physiology and pathology.

1. THE BODY AS A WHOLE

Students will be required to learn the concept of the body as a whole, with its various systems inter-relating in their positions and functions: including metabolism, temperature regulation and response to disease.

1. SURFACE AND REGIONAL ANATOMY

Students will be required to demonstrate knowledge of the following points and appreciate their relevance to accurate positioning of the patient for radiography or for treatment.

a) Surface landmarks which indicate the position and extent of structures within the body.

b) Conventional planes and lines of the skull, neck, thorax, abdomen and pelvis.

c) Subject types; posture; respiratory phases: their effects upon the shape, size and position of viscera.

d) Vertebral levels: the usual sites of structures in the neck, thorax, abdomen and pelvis; transverse sectional anatomy, especially at 6th cervical, 4th/5th thoracic and lst lumbar vertebral levels.

e) Body cavities and their boundaries and subdivisions:

The cranial cavity: the anterior, middle and posterior cranial fossae; the midline and its significance.

The thoracic cavity, thoracic inlet and mediastinum.

The abdominal and pelvic cavities; the peritoneum: its disposition, attachments and functions; retroperitoneal structures.

f) The diaphragm: its structure, openings, functions; blood and nerve supply; main relations. Effects upon movement, of phrenic nerve injury, subphrenic abscess, and lung collapse.

 4. RADIOGRAPHIC APPEARANCES

Students must be aware that the various tones which form a radiographic image represent the composition and size of the anatomical structures; and that the natural appearance can be changed by the presence of a radiological contrast agent.

Students must be aware of the two-dimensional limitations of a radiographic image.

Students must learns and may be required to identify the radiographic appearances of anatomical structures, physiological processes and pathological changes, as detailed in this syllabus.

**CELLS AND TISSUES**

1. Typical Animal Cell

Plasma membrane; cytoplasm and nucleus; chromosomes and genes; functions of nucleus and cytoplasmic structures; mitosis; radiation sensitivity in elation to mitosis; relevance of maximum permissible doses of radiation laid down in Codes of Practice.

1. Elementary Embryology '

(Note: Embryology is included at this point in the syllabus to link with cell and tissue differentiation, but it also relates to study of the body as a whole and to pregnancy.)

Meiosis and genetic significance; the genetic effects of radiation.

Ova and spermatozoa; fertilisation of the ovum.

Outline of embryonic development; primary cell layers. Terminology of tumours.

1. Tissues

Epithelial tissue - types and sites; glands; membranes.

Connective tissues, with particular emphasis on: fibrous tissue, cartilage, cancellous and compact bone.

Muscle: involuntary, voluntary, cardiac.

Nerve tissue.

Effects of radiation on various tissues.

1. Matrix Substances

Extracellular fluid; lymph; plasma; cerebrospinal fluid.

1. Blood

Composition and functions.

Cells: sites of origin, development, shape and size, number and percentage, functions, approximate length of life, site of destruction.

The clotting process.

Elementary coverage of ABO groups and Rhesus factors.

Common blood disorders.

Elementary coverage of blood tests.

*(Physiology of body fluids, Intracellular and extracellular fluid, Electrolyte balance, Mechanism of coagulation and thrombus formation, Constituents of plasma; plasma proteins; plasma cell volum, Haemotological indices; the blood count; colourindex.Total blood volume; blood pH.*

*Mean corpuscular volume (M.C.V.))*

Mean corpuscular haemoglobin (M.C.H.)

Erythrocyte sedimentation rate (E.S.R.)

Haemolysis , erythroportin.

Blood groups and agglutination, Rhesus factor.

Fibrinolysis.

Effects of radiation upon blood-producing tissues, and practical measures to minimize these effects. The relevance of bone marrow transplants to myeloproliferative diseases.

1. Skin and Appendages

Dermis and epidermis: structure and functions.

Effects of radiation: reactions; erythema and epilation.

(Although included in this section because of it relevance to tissue, the skin must also be brought into consideration of temperature regulation, excretion and the special sense organs)

**PATHPLOGICAL PROCESSES**

Diagnostic students will be concerned with demonstrating the presence of disease and its spread or resolution. In order for radiographic techniques to be appropriate and effective, a working knowledge of pathological processes is required.

For similar reasons, therapeutic students must study the development and treatment of diseases with which their patients present.

Bacteria and viruses.

Infection: its transmission, prevention and treatment; the management of patients with known or suspected infectious diseases.

Virulence; toxins; the body’s defenses against infection; inflammation.

The effects of radiation on inflammatory processes; formation of antibodies; principles of immunotherapy; transplant rejections; immune response; immunity; cytocidal response (for particular attention of therapeutic radiography students).

Benign and malignant tumours. Methods of spread of malignant tumours.

Difference between benign and malignant tumours.

Broad classification of tumours.

**THE LOCOMOTOR SYSTEM**

1. **Bones**

Students will be required to demonstrate knowledge of 2 the classification, structure, architecture and function of bones; formation of bones; formation of cartilage and membrane; remodelling; factors controlling growth of bone.

Common fractures and their orthopaedic management; the healing process following a fracture; factors which influence the rate of healing; the radiographic appearances of the stages of healing.

The causes, radiographic appearances and treatment of common metabolic, malignant and infective bone diseases; an outline of demineralization; its causes and radiographic significance.

The macroscopic appearance of the individual bones of the skeleton: including their type, main parts (e.g. shaft, extremities), particular features

(e.g. processes, foraminae, articulations, and ossification centres .)Chronology of development of bones to be included. Metabolic process in bone; calcium and phosphorus metabolism.

Groups of bones which form functional units: the skull (including separate consideration of the cranium, facial skeleton and orbits); the vertebral column (its ligaments, functions, and curvatures normal and abnormal); the thoracic cage (including coastal cartilages); pelvis (including sex differences and dimensions of obstetric importance); shoulder girdle; hand and foot.

1. **Joints**

Students will be required to demonstrate knowledge of: functions of joints; classification of joints (including examples of each); types of synovial joint (including examples of each); structure of larger synovial joints of the body (including the bones involved), articular cartilage, capsule and strengthening ligaments, synovial membrane and fluid, bursae, intracapsular structures, blood supply, movements and main muscles producing these movements.

The nature and, where applicable, the name of common dislocations, fracture dislocations, subluxations and joint diseases; and their orthopaedic management.

1. **Muscles**

The general emphasis should be on learning muscle groups rather than individual muscles. A knowledge of individual muscles may be required,

however, when they are visible radiographically: either normally (e.g. the psoas) or when their tendons are calcified.

**THE CARDIOVASCULAR SYSTEM**

1. **The Heart**

Position and relation within the thorax; structure - chambers, valves, structure of walls, coronary vessels; surface marking of the apex; function -action as a double pump; the pericardium; factors affecting heart beat, volume and rate; common diseases of the heart; common congenital abnormalities of the heart and great vessels.

1. **Blood Vessels**

The structure and function of arteries, veins and capillaries; common diseases of blood vessels; thrombosis, embolism and infarction.

1. **The Pulmonary Circulation**

Pulmonary vessels; exchange of gases.

1. **The Systemic Circulation**

The aorta and its branches; surface markings of the arch and the bifurcation; the main arteries supplying the body; the venae cavae and their main tributaries; anastomoses; the arterial supply and the venous drainage (superficial and deep) of regions - e.g. upper limb, head and neck, brain; the portal circulation.

1. **Physiology of the Circulation**

Arterial blood pressure - systolic and diastolic; pulse pressure and rate; method of measuring blood pressure; venous return, circulation rate; control of circulation.

1. **HAEMODYNAMICS**

Volume flow, arterial blood pressure.

Peripheral resistance and factors affecting it.

Pressure changes in the heart.

Murmurs, heart block, fibrillation.

Properties of cardiac muscle.

Electrocardiographs.

Coronary circulation and flow.

Developmental and acquired abnormalities.

Perfusion.

**The lymphatic and reticulo-endothelial systems**

The formation and function of lymph; structure and functions of lymph vessels and nodes; node groups; lymphoid tissue, the thymus and its role in immunity.

The cysternachyli, thoracic duct, right lymphatic duct, lymphatic drainage of regions of the body," with special mention of the tongue, breast, uterus ovaries and testes.

The spleen: its shape, size, position, surface marking, relations; capsule, trabeculae, pulp, sinusoids, R.E. cells.

R.E. cells in the body; including those in the liver, bone marrow and lungs.

Myeloproliferative diseases: Hodgkin’s disease, mediastinal obstruction.

**The respiratory system**

The nasal cavity, paranasal sinuses, pharynx: their structure, functions and communications.

The larynx: cartilages, membranes, ligaments, joints, vocal and false cords, blood supply, lymph drainage, nerve supply, relations and functions.

The trachea: size, extent, construction and relations; relationship to midline in the neck, thoracic inlet and thorax; surface markings of the bifurcation.

The main bronchi and their branches: position, shape, size, structure, relation to the lobes of the lungs; blood and nerve supply; lymph drainage.

The lungs: shape, size, structure; relations; functions; blood and nerve supply.

The pleurae: their construction and function.

Respiration ~ internal and external; ventilation of the lungs; respiratory movements; chemical and nervous control of respiration; transport of respiratory gases in the blood.

Common diseases and tumours associated with the respiratory system which are of radiographic significance.

**THE DIGESTIVE SYSTEM**

1. **The Alimentary Tract**

The mouth: divisions and boundaries.

The tongue: size, shape, position, attachment, structure, papillae, relations, blood and nerve supply, lymph drainage.

The teeth: types and numbers of teeth in primary and secondary dentitions; structure of a typical tooth; relation to gum and alveolar margin; variations of crowns and roots of different types of teeth; chronology of normal eruption.

The salivary glands: position, size, structure and relations of parotid, submandibular and sublingual glands and their ducts; blood and nerve supply, functions; surface markings.

The pharynx: shape, size, structure, relations, function, blood and nerve supply, lymph drainage.

The oesophagus: size, shape, position, structure, deviations from midline, sites of normal and pathological narrowing; blood and nerve supply, lymph drainage, relations, functions.

The stomach: position, shape, size, variations with subject type, posture and contents; structure - gross and microscopic; blood and nerve supply; relations; functions; common pathological conditions; ulcer sites; common surgical treatments of ulceration and malignancy.

The small and large intestine: shape, size, position and structure of the various parts; blood and nerve supplies; lymph drainage; relations and peritoneal attachments; diseases and tumours relevant to radiography; colostomy and ileostomy.

**2.The Liver**: size; shape, location, structure, blood supplies; surface markings. Functions, including reference to excretion of radiological contrast agents liver failure, obstruction, serum bilirubin.

Hepatic circulation. Structure of liver cells.

 **3. The Biliary Tract**: position, shape, size and structure of the gall bladder, intra-hepatic ducts, union with pancreatic duct.

Functions of the biliary system; storage and concentration in the gall bladder, formation of calculi; surgical treatment of cholelithiasis; choleretics,

with reference to their use during radiography.

Relations and surface marking of the gall-bladder; variations in position, with subject type, posture and respiratory phase.

Common diseases of radiographic' importance.

**4**. **The Pancreas**

Shape, size and relations, blood supply, microscopic structure.

Digestive(exocrine) functions.

Surface markings and relation to transpyloric plane.

Radiographycally significant diseases.

(Note:- the endocrine function of the pancreas will probably be more appropriately considerd with the other endocrine glands)

**5.Nutrition and Digestion**: the mechanical and chemical processes must be considered in outline, by which food is converted into digestible substances and absorbed into the body; mastication, deglutition, peristalsis, the various enzymes and other digestive secretions from the alimentary tract and its accessory organs and glands.

Elementary dietetics, important elements and vitamins.

Common malnutritional diseases; effects of radiation upon digestion.

Digestive secretions and their control.

**THE URINARY SYSTEM**

**Kidneys and Ureters:**

Size, shape, position, relations, surface markings, macroscopic and microscopic structure, blood supply, lymph drainage.

**Bladder and Urethra:** `

Size, shape, structure, position and relations in male and female; blood supply; lymph drainage; innervation of urethral sphincter.

**Physiology:**

Functions of kidneys; composition and formation of urine; elementary coverage of Water, electrolyte and acid/base balance, acidification and concentration

of urea; special reference to excretion and concentration of radiological contrast agents.

Renal clearance.

Glomerular filtration rate.

Tubular secretion and resorption.

Mechanism of micturition.

**Pathology:**

Common diseases of radiographic importance; urinary calculi and common sites of impaction; obstruction and hydronephrosis; renal artery stenosis and hypertension.

Dialysis

**THE REPRODUCTIVE SYSTEMS**

**The overies, Uterine Tubes, Vagina and Vulva**

Size shape position relations to peritoneum and pelvic viscera, structure; blood and nerve supply; lymph drainage.

**The Breasts: \_**

Structure, blood supply and lymph drainage, lactation. Comparative changes in pregnant and post-menopausal subjects.

**The Male Reproductive System:**

Scrotum and penis, testes, epididymus, spermatic cords, seminal vesicles, ejaculatory ducts, prostate gland, urethra.

**Physiology**

The menstrual cycle; influence of hormones. Ovulation, conception; implantation of fertilized ovum, action of oral contraceptives: the 10 day rule

Outline of pregnancy; growth of embryo and fetus.

Menopausal changes.

The placenta.

**Pathology**

Common diseases and tumours; primary and secondary infertility; sterilization.

**THE NERVOUS SYSTEM**

**1.The Central Nervous System:**

***The brain***: the lobes, main sulci and gyri of the cerebral hemispheres, corpus callosum, basal ganglia, thalamus, hypothalamus, pineal body, midbrain, pons, medulla oblongata, cerebellum, ventricular system, blood supply.

***The spinal cord***: size, position, enlargements, conusmedullaris, filumterminale, caudaequina; structure and function; relationship to vertebral levels.

***The meninges***: structure and functions of epidural, subdural and subarachnoid spaces, cisterns.

***Cerebrospinal fluid***: composition, formation, functions, circulation and reabsorption, lumbar puncture, cisternal puncture, hydrocephalus, spina bifida.

Heat regulation centre.

Blood brain barrier. Basal ganglia. Hypothalamus. Transverse sectional anatomy of spinal cord.

Common diseases of radiographic importance.

**2.The Peripheral Nervous System**: The cranial nerves: their names and functions.

The main spinal nerves and plexuses; sensory and motor pathways; reflexes.

**3. The Autonomic Nervous System**: Outline of function; common diseases and tumours.

**4. The Eye and the Ear**: Structure and function.

Physiology of binocular vision; lacrimal apparatus.

**The endocrine system**

***The pituitary, thyroid, parathyroids and supra renal gland, and the islets of Langhans(pancereas), gonads***

Shape, size, structure, position, relations, blood supply.

**Physiology**

The individual functions, hormones, and diseases caused by hormone disorders, should be considered in relation to these glands, and the general functions of the endocrine glands (including placenta) and thymus should be considered in relation to the nervous system.

**Special sense organs**

*The Eye, The Ear, The Nose, The Tongue, The Skin*

Considered elsewhere in the syllabus under appropriate systems.

**Equipment for Diagnostic Radiography**

**CONTENTS**

Aims and Objectives

The Electrical Circuit in the X-Ray Set: Mains Supply, Control and Stabilizing Equipment

Diagnostic High Tension Circuits Meters. Exposure Times and Switching,

Interlocking Circuits

The X-Ray Tube: Types Construction and Operation, High Tension Cables, X-Ray Tube

Stands

Control of Scattered Radiation: General Principles, Grids, Collimators and Beam Centering Devices

Special Equipment: Fluoroscopic Equipment, Tomographic Equipment, Portable and

Mobile Equipment, Dental Equipment, Mammographic Equipment, Equipment for

Neuroradiography, Accident and Emergency Equipment.

Image Intensifiers

Rapid Serial Equipment

Care and Maintenance of Equipment

**Equipment For Diagnostic Radiography**

**Minimum Number of Teaching Hours 100**

**AIMS AND OBJECTIVES**

The practical aspects of the subject should be emphasized, although some revision of the physical principles of equipment design may be necessary.

The aim is to provide the student radiographer with sufficient general and detailed knowledge to:-

(a) Appreciate the limits and hazards associated with the use of X-ray equipment with regard to the safety of patients, staff and equipment,

(b) Make full use of both the main and accessory equipment, handling them with understanding, confidence and care;

(c) Recognize faulty behaviour of the equipment.

On completion of the course, The student should be able to demonstrate orally or

in writing:

(i) A familiarity with the external aspects of the equipment;

(ii) An understanding of the construction and use of the equipment and controls (if any) to such a degree that the facilities provided by the equipment might be fully utilized;

(iii) A knowledge of safety precautions to be taken when using the equipment in order to safeguard patients and staff and extend the useful working life of the equipment; ,

(iv) A knowledge of routine care and maintenance measures to be taken to ensure efficient and economic operation of the equipment;

(v) A knowledge of simple tests which can be made to ascertain the condition of the equipment or identify simple faults; `

(vi) A knowledge of such further features as may be separately specified with each of the listed equipment;

(vii) Participation in the demonstration listed in the following text;

(viii) An ability to recognize and interpret circuit diagrams of the equipment or parts of the equipment and draw block diagrams of the equipment or parts of the equipment.

 (ix) Describe the principles and modes of operation of currently available advanced diagnostic equipment which a radiographer might be expected either to use directly or to assist in using;

(x) Interpret data such as Hazard Warning Notices, Manufacturers’ Descriptions and Specifications and other data relating to equipment;

(xi) Discuss broadly the possible implications of equipment in respect of departmental design and any impact on the department’s capability for Workload staffing and revenue consequences;

(xii) Evaluate comparable items of equipment and assess their suitability to particular purposes;

(xiii) Appreciate aspects of quality control of radiographic equipment, for example the use of step wedges, phantoms and other tests to determine Optimum performance of equipment; `

(xiv) Advise in forward planning; selection of equipment, planning of general and specialized X-ray rooms;

(xv) Illustrate the operation of X-ray set components with the aid of circuit diagrams.

**The electrical circuit of the X-ray equipment**

MAINS SUPPLY

Polyphase supplies, power distribution.

Availability of different voltages.

Feeder cables, line voltage drop.

Mains switches, fuses, circuit breakers.

Earthing.

Insulation.

Safety and security of plugs and sockets.

Demonstration of location and replacement of ‘blown’ fuses.

**CONTROL AND STABILISING EQUIPMENT**

To be dealt with under the following headings:

(a) Purpose of device.

(b) Method of use.

(c) Effects of misuse or malfunction.

(i) Mains voltage compensation. (Experiments to show the effects of incorrect compensation, including use of step-wedge.)

(ii) Mains resistance compensation.

(iii) Mains frequency compensation.

(iv) Kilovoltage compensation.

(v) Space charge compensation.

Control of X-ray tube voltage;

Control of X-ray tube current; filament circuit.

**DIAGNOSTIC HIGH TENSION CIRCUITS**

Basic principles of the types listed below with a comparison of the radiographic merits and applications.

Self rectified (one pulse); single phase full-wave rectified (two pulse);three phase, six and twelve pulse; capacitor smoothed; capacitor discharge.

Grid control systems.

(Experiments using penetrameter or step-wedge to check generated output.)

Falling load generators.

Generators providing for ‘organ (anatomical)’ selection of exposure-factors.

Implications of automated equipment on the working of the Department.

(Candidates should be able to compare generators and appreciate their relevance to particular usages).

**METERS**

Meters commonly found on diagnostic X-ray equipment and their purpose.

Position in circuit.

Reading meters relative to exposure.

Interpretation of meter readings with regard to correct operation of the unit.

General principles of logical devices giving a digital read-out of meter information, with examples.

**EXPOSURE TIMERS and SWITCHING**

Timers; basic principle of clockwork, electronic and autotimers.

Practical aspects of their suitability for particular applications and limitations.

Exposure switching; general principles and methods of switching in low tension and high tension circuits

Practical aspects in the choice of method of exposure timing switching for particular applications.

Solid-state switching devices.

Use of logic circuitry in switching.

(BLOCK TYPE DIAGRAMS only will be required)

Experiments to show use of the spinning top to check exposure duration

Use of check films to show integrity of autotimers.

**Interlocking circuits**

General Principles of interlocks

X-ray tube overload protection; limitations of exposure interlocks.

(BLOCK TYPE DIAGRAMS only will be required)

**THE X-RAY TUBE**

**TYPES CONSTRUCTION AND OPERATION**

Rotating anode and X-ray tubes; general principles of design and common variations.

Examples of types and applications.

X-ray tube ratings and the use of rating charts and cooling charts.

Care of the X-ray tube and recognition of symptoms of faulty operation.

Practical considerations in the choice of operating conditions; focal spot size; speed of anode rotation; angle of target inclination; grid control.

Experiments to show ‘pinhole’ radiograph of the effective focal area; effects of the choice of focal area on geometrical unsharpness; anode ‘heel’ effect; extra-focal radiation.

Exploration of capabilities of different types of X-ray tube with reference to the type of work

for which the tube is needed.

Alternate methods of precise measurement of focal spot size.

**HIGH TENSION CABLES**

Construction and design.

Earthing and insulation in H.T. circuits.

High tension plugs and sockets.

Safety and security of H.T. Plugs and sockets.

**X-RAY TUBE STANDS**

Types, advantages, disadvantages, and applications

**Control of Scattered radiation**

**General Principles**

Need to control secondary radiation.

Effect of secondary radiation on the radiograph.

**GRIDS**

Purpose and function of a grid; effect on exposure factors and radiation exposure factors and radiation dosage; circumstances justifying the use of grids

Stationary grids; structure and materials; grid ratio; lines per centimetre; selectivity; parallel and focused grids; cross-hatch grids; gridded cassettes.

Effects of misusing stationary grids.

Experiments to show the effectiveness of grids and shielding in reducing the effects of scattered radiation.

**M0VIN G GRIDS**

Purpose, advantages and disadvantages, types of movement.

Demonstration to show types of grid movements.

Desired characteristics and choice of a grid with reference to particular categories of examination.

**COLLIMATORS AND BEAM CENTRING DEVICES**

Basic principles of operation and use of cones and diaphragms;

Construction and types of diaphragm, single and multileaved.

Experiments to show the effectiveness of collimation in reducing the effects of scattered radiation.

Centre finders. Optical delineators.

Light beam devices.

Experiment to check the alignment of a light beam collimator.

Evaluation of the effectiveness of devices which control scattered radiation.

**SPECIAL EQUIPMENT**

**FLUOROSCOPIC EQUIPMENT**

The fluoroscopic screen. Tilting tables.

Explorators (serial changers, spot-film devices) and accessories.

Specialized tables.

Fluoroscopic tables giving tilts in two planes.

Radiation protection including integrating timer.

**TOMOGRAPHIC EQUIPMENT**

Tomographic principles.

Basic requirements in equipment and controls.

Tomographic attachments and purpose-built units.

Movements and applications.

Principles of simultaneous multi-section tomography including multi-section cassettes.

**Computerised tomography.**

**PORTABLE AND MOBILE EQUIPMENT**

Types

Factors affecting choice of mobile equipment.

**DENTAL EQUIPMENT**

**MAMMOGRAPHIC EQUIPMENT**

**CATHETERISATION TABLES**;

Types; facilities and applications

**EQUIPMENT for NEURORADIOGRAPHY**

Advanced neurological equipment, including isocentric systems; types, facilities and applications.

**ACCIDENT and EMERGENCY EQUIPMENT**

including special chairs and trolleys.

**Specialized accessories for use during advanced examinations in angiography and similar procedures.**

**IMAGE INTENSIFIERS**

The following equipment to be considered under the listed headings:

(a) Purpose

(b) Advantages and limitations of different types

(c) Precautions in use and handling

Image intensifier tubes.

Types of optical coupling.

Methods of viewing and recording the intensified image.

Use of closed-circuit television.

Equipment for fluorography and cine fluorography.

Video-tape recording.

(Magnification of the intensified image.

Evaluation and comparison of recording systemsfor the intensified image.)

**DIGITAL FLUOROSCOPY EQUIPMENT**

**RAPID SERIAL EQUIPMENT**

Rapid cassette changers.

Rapid film changers; cut or roll films; full size film or miniature film.

Biplane equipment.

Radiation protection.

Use of relevant X-ray rating charts. Use of angiographic and cine X-ray tube rating charts

**CARE AND MAINTENANCE OF EQUIPMENT**

General principles, hygiene, aspects of electrical and mechanical efficiency and safety.

Importance of equipment upkeep. `

Cleaning routines and inspections.

General care in use and recognition of malfunction.

Special care of mobile X-ray equipment.

Reporting and recording equipment state.

Simple tests and cheeks of equipment in use.

**RADIOGRAPHIC PHOTOGRAPHY AND IMAGING PROCESSES**

**CONTENTS**

Introduction

Aims and Objectives

Photographic Principles

Sensitometry

Film Materials

Storage of Film Materials

Intensifying Screens

Film Cassettes

The Radiographic Image

Identification and Presentation of Radiographs

Viewing of the Radiographic Image

The Processing of Film Materials

Automatic Processing

Manual Processing

Silver Conservation and Recovery

The X-Ray Darkroom Duplication and Subtraction

Imaging Principles of Special Imaging Techniques

Automated Film Handling Systems

Photofluorography

**RADIOGRAPHIC PHOTOGRAPHY AND IMAGING PROCESSES**

**Minimum number of teaching hours 100**

INTRODUCTION

The student radiographer should not only be familiar with the principles of radiographic imaging and structure of the image, but be able to apply this knowledge to the production of the radiograph and the assessment and control of image quality.

Wherever possible, emphasis should be placed on application with experiments designed to develop in the student practical skills which cannot be obtained from text books.

The contents of this section of the syllabus should not be treated in isolation to other sections, and where they exist, inter-relationships should be emphasized. This aspect may be reflected in examination questions.

**AIMS AND OBJECTIVES**

The student should be able to

1. describe and practice the procedures employed in producing a radiographic image.
2. control and manipulate parameters associated with exposure and processing to produce a required image quality.
3. effectively use and routinely assess image recording and processing systems.

iv. set up an image quality control system for automatic film processing, evaluate

 and act on the results.

1. understand the parameter of image quality and their effect on visualization of image information content.
2. assist in the administrative procedures associated with radiographic images.
3. carry out the routine procedures associated with maintenance of imaging and processing systems.
4. describe recent advances in radiographic photography and other imaging processes with which a radiographer might be involved.
5. discuss the principles and implications of such advances and their effect on future trends.
6. analyze, evaluate and compare imaging processes and procedures and the equipment and facilities for such procedures.
7. interpret the data relating to imaging materials and equipment as presented by

 manufacturers etc.

1. apply photographic principles to the solution of familiar problems encountered in imaging procedures, planning and design of facilities, and operational policies for such procedures.
2. analyze unfamiliar events encountered in image processes and procedures, and draw conclusions.
3. evaluate resources and control of resources for imaging procedures.

**PHOTOGRAPHIC PRINCIPLES**

This section is an Introduction to the properties of film materials used in imaging systems and the significance of these properties relative to the required final image.

The electromagnetic spectrum.

The silver halides and their response to exposure to electromagnetic radiation.

 Spectral sensitivity and its meaning. Effect of sensitizers on spectral sensitivity.

Effect of grain size on film response to exposure.

Grain size distribution; its practical significance.

Effect of sensitizers on film response to exposure.

Structure of the film emulsion. Properties of the film emulsion relative to film storage, handling, exposure and processing.

Simple treatment of latent image formation and subsequent transformation to a visible image in conventional X-ray film.

**SENSITOMETRY**

While the importance and use of characteristic curves should be appreciated, it is intended that the contents of this section should be dealt with qualitatively.

Where the justification of a particular point using quantitative methods is felt necessary, then these need not be Withheld from the student.

Emphasis should be placed on the practical aspects and reinforced by demonstration and experiment by the student. It is the effect of variation in the factors considered and their influence on the imaging process that is of prime importance at this level.

Photographic density. Its logarithmic nature. Log-relative exposure; its meaning and reason for use. Exposure range. Density range.

Regions of the characteristic curve.

Curve shapes for different films used in practice.

Gross fog level and factors affecting it associated with accidental exposure of the film to light, X-rays or 7-rays, film storage, film processing and handling. Effect on characteristic curve of variation in fog level.

Gradient at a point on the curve as a measure of film (inherent) contrast

Average gradient, and its significance.

Factors affecting film contrast.

Relative film contrast for the different films used in practice.

Film latitude. Average gradient and film latitude.

Exposure latitude. Effect of kV on exposure latitude.

Effect of film latitude on exposure latitude.

Relative film speed related to a specific photographic density.

Exposure factor variation related to the characteristic curve.

The use of sensitometry and characteristic curves to evaluate and compare films.

**FILM MATERIALS**

The use of film material is an essential part of the imaging process and its behaviour under the imaging conditions chosen determines the quality of the image obtained. The student should appreciate the factors influencing film material behaviour extending to an understanding of how to achieve an optimum image quality for a given film material under a given set of conditions. This knowledge should be gained through integration of information from this subsection with information from other relevant subsections.

**(a) Metric film sizes. Films for manual and/ or automatic processing**.

Handling of exposed and unexposed film.

Common faults due to improper handling.

Unpacking film material. Function of wrappings.

Comparative structure of duplitised and single emulsion films.

Different film layers and their function.

Relative film speed, its meaning and practical significance.

Test for relative film speed.

Factors affecting relative film speed.

**(b) Duplitised X-ray Film**

Direct exposure (non-screen) film.

Screen type film. Arrangement of film and intensifying screens for exposure.

Electromagnetic radiation to which each type is exposed.

Processing requirements.

Applications of duplitised X-ray film.

Relative advantages and disadvantages of duplitised X-ray film.

Spectral sensitivity and safe lighting requirements.

Comparison of relative film characteristics including a measure of relative film speed.

**(c) Single Emulsion X-ray Film (screen-type film)**

Identification of emulsion side.

Arrangement of film and intensifying screen for exposure.

Electromagnetic radiation to which the film is exposed.

Processing requirements.

Applications of single emulsion film.

Relative advantages and disadvantages of single emulsion film.

Spectral sensitivity and safe lighting requirements.

Comparison of relative film characteristics including a measure of relative film speed.

(d**) Single Emulsion film for Photofluorography**

Identification of emulsion side.

Arrangement of film for exposure.

Film formats. Roll and cut films. Cine film.

Electromagnetic radiation to which the film exposed.

Processing requirements.

Relative advantages and disadvantages of single emulsion film in photofluorography.

Spectral sensitivity and safe lighting requirements.

Comparison of relative film characteristics.

Relative film speeds for different photofiuorographic films.

Applications of photofluorographic film.

**(e) Single Emulsion films for duplication and subtraction**

Identification of emulsion side.

Processing requirements.

Electromagnetic radiation to which the film is exposed.

Reasons for single emulsion.

 Required film characteristics, reason for unity gradient.

Effect on characteristic curve of a change in the spectrum of the source of exposure and/or a variation in processing conditions.

The practical significance of the effects of such changes should be indicated.

**(f) Other Film Materials**.

Film materials suitable for thermography, diagnostic ultrasound,

radionuclide scanning and radiation monitoring should be considered

(Students should be familiar with recently introduced film materials, their spectral sensitivity, advantages, limitations and applications in radiography.)

**STORAGE OF FILM MAERIALS**

The image quality obtained with a given film material depends in part on the storage conditions for that material. The student should be aware of what constitutes optimum storage conditions and the possible effects on the end result when these conditions are not met. The student should also appreciate the degree of latitude possible in film storage conditions, and understand the principles and methods involved in the use of a film store.

**Storage of film material**

**(a) Main stock of unexposed film**

Relationship of store to main radiographic darkroom.

Storage requirements - space, shelving, lighting, ventilation, ambient temperature, relative humidity.

Protective measures against harmful gases, X-rays and radio-active materials and physical damage.

Shelf life of films storage fog. Assessment of storage fog.

Film box identification for stock rotation.

Method of use of the film store.

**(b) Unexposed Elms in use in the darkroom**

Storage receptacle. Separation of film sizes.

Safety from white light exposure.

Separation and identification of similar size film of different speeds.

Temperature and relative humidity.

**(c) Outside the darkroom**

Films in cassettes and film holders.

Enveloped wrapped film.

Use of a cassette storage container.

**(d) Exposed, unprocessed Elms**

Method and length of storage. Reason for storage. Temperature and relative humidity.

**(e) Stock Control**

Methods of stock Control

Statistical information required for stock control and an indication of the uses for this information

Security Considerations

The planning and management of stock control and ordering systems. Use of computers in stock control.

**INTENSIFYING SCREENS**

The integration of film material with intensifying screens changes the imaging characteristics of the system and alters the exposure requirements. A thorough understanding of these changes and their relative advantages is necessary. The relative disadvantages should not be neglected and the student should have the opportunity to demonstrate by experiment the relative advantages and disadvantages of the uses of intensifying screens with the aid of suitable test objects.

Intensifying screens can be very costly and emphasis should be placed on the care of such screens. In addition to the familiar use of intensifying screens in cassettes, screens are used in automatic equipment such as is employed for ‘daylight’ systems and rapid film changing. Consideration should be given to these situations and testing procedures adapted to these new conditions, e.g. testing film/intensifying screen contact in a ‘daylight’ system.

(a) Structure and function of intensifying screens. Effect of kV and mA variation on emitted radiation intensity by the intensifying screen.

Physical nature of fluorescence. Quantum mottle (brief introduction).Intensifying screen (structure) mottle. ~Common phosphors used. Effect of activators on emission intensity and spectrum should be dealt with briefly. Emission spectra for different intensifying screen phosphors related to the matching of film material and intensifying screen(s). lntensification (intensifying) factor. Factors affecting intensification factor. Relative speed of intensifying screens. Test to determine the relative speed of intensifying screens. Factors affecting the relative speed of intensifying screens.

Film contrast amplification. Relative response of intensifying screens and automatic exposure

devices to exposure to X-rays; importance of standardization.

(b) Types of intensifying screens..

Single screen systems; arrangement of film and screen for exposure.

Two screen systems.

Multiscreen systems; minimum kV values for multiscreen systems.

(c) Mounting intensifying screens.

Care and cleaning of intensifying screens.

 Intensifying screen contribution to radiographic image unsharpness.

Test for intensifying screen and film contact.

(Students should be familiar with recently introduced intensifying screens, the phosphor used, their advantages, limitations and practical applications. Methods of objective and subjective evaluation of intensifying screens.)

**Film Cassettes**

While the cassette acts as a protective container for film and screens, it has a significant role in the imaging process and its importance should not be underestimate. Exercising care in use, together with regular servicing is essential in the maintenance of radiographic standards and the student should be able to recognize image faults due to inadequacies of the cassette.

(a) Structure and functions of an X-ray cassette. Role of the cassette in the imaging process.

(b) Types of X-ray cassette to include single film cassettes with single and paired intensifying screens, cassettes for multisection tomography and multiple radiography, gridded cassettes, vacuum cassettes, cassettes used in xeroradiography and film holders for films used without intensifying screens.

(Consideration should be given to cassettes which may be used in the conventional sense and also have design features enabling them to be used with automatic film loading/unloading equipment).

(C) Role of the cassette in film identification systems. Identification systems for cassettes and intensifying screens.

(d) ln-use cassette storage.

Loading and unloading a cassette.

Care and cleaning of cassettes.

Testing a cassette for light leakage.

Records relating to cassettes.

(The relative merits of different cassettes including those used with automatic systems

Automatic film feed and receive (take-up) cassettes used in systems producing a full size image and in systems producing a minified image. Cine and rapid sequence exposure systems should be considered and the student should have the opportunity to handle, load and unload such cassettes. )

**THE RADIOGRAPHIC IMAGE**

To achieve the required image quality the student must know and understand the many contributing factors and be able to control and manipulate those factors capable of control and manipulation and compensate for those which are not. Making economies, avoiding errors and minimizing radiation dose should be kept in mind when trying to achieve a given image quality. The student should also appreciate that a certain latitude is allowable in their concept of optimum image quality because of the human element involved in the assessment of image information. It cannot be over emphasized that a good working knowledge of the information in this subsection is necessary if the student is to produce the kind of radiographic results required.

**(a) Exposure factors**

kV, mA and exposure time.

mAs and the reciprocity relationship.

Reciprocity failure.

Photographic (image) density, its meaning.

mAs variation and image density. kV variation and image density.

Calculation of required exposure factors when changing kV, mA, exposure time, F.F.D., intensifying screens, film speed, secondary radiation grid.

**b.) Automatic Exposure Devices**

Use of automatic exposure devices including automatic exposure in miniature radiography. Choice and position of measuring fields relative to patient part. Image density related to radiation dose. Effect of scatter. Types of screens, film and cassettes related to standardization and calibration. Effect of changes in film speed, intensifying screen speed. Effects of kV and mA variations.

The emphasis here should be on the relationship between the choice of exposure factors, the patient, and the image quality obtained, related to the effect the automatic exposure device has on image quality. It is not intended that a detailed study be made of the operation of these devices. This should be left to the equipment section of the syllabus to which the above subsection should be related.

**C). Radiographic Image Contrast**

Subjective and objective radiographic contrast, their meaning and significance in practice.

 (i) film contrast and the factors affecting it such as type of film, intensifying screens, photographic density at which measured, fog and processing.

(ii) subject contrast and the factors affecting it such as subject thickness, atomic number and density, kV selected, beam filtration, output waveform, use of radiological contrast agent.

(iii) scattered radiation, its formation, effects, and methods of minimizing its effects should also be considered.

*(****Factors affecting radiographic contrast****. This should include a consideration of film contrast an the factors which affect them. The influence of viewing conditions on subjective contrast should not be neglected. The effects of scattered radiation should be emphasized and methods of minimizing these effects fully considered. Concept of optimum image contrast, its achievement, and relationship to image information content)*

**d). Radiographic Image Unsharpness**

Image unsharpness, its meaning, production and effects. Image definition, its meaning.

The student should be exposed to an elementary treatment of the topics in the first half of the course, a fuller consideration being left to the second half. These topics

would include:-

Factors affecting image unsharpness such as focus size, focus/film distance, focus/object distance, object/ film distance, subject structure, subject movement, intensifying screen/film contact.

Image graininess and the factors affecting it such as intensifying screen mottle, quantum mottle, type of film, processing, should also be considered.

(Factors affecting image unsharpness. Methods of minimizing image unsharpness.

Magnification, minification and distortion.

This section should include an elementary consideration of resolution, its relationship to image contrast and unsharpness, and its effect upon the visualization of image information. Resolution of individual parts of an image recording system and the system as a whole should be considered in very simple terms.

Evaluation of resolution, limitations of practical methods. Outlines of line spread, contrast transfer and modulation transfer functions, and their uses. Resolution and noise and their implications in the

imaging process.)

**IDENTIFICATION AND PRESENTATION OF RADIOGRAPHS**

The considerable importance of the relatively simple information contained in this section cannot be over emphasized. The student should realize the possible consequences of both incorrect identification and the lack of identification of radiographs.

(a) Information required to identify radiographs.

Single radiographs, radiographs in sequence.

Consideration should be given to the additional identification information that may be required in plain radiography, macro-radiography, tomography, and procedures using a radiographic contrast agent.

(b) Technique of film identification. Methods and equipment of recording identification information on film used in radiography; full size radiographs (including the mounting and identification of dental films), miniature films (including cine films).

Fully automated systems for identifying films should be considered along with other methods and the principles involved in the operation of such systems should be understood.

(c) Documentation, filing and retrieval systems for radiographs and other radiographic imaging material.

(Automatic and computerized radiograph and radiographic image storage and retrieval systems including random filing systems. The planning and management of such systems and their effect on department design and work flow patterns.)

**Viewing of the radiographic image**

The subjective appreciation of the finished radiograph, using an illuminator, is the most important and usually the only means at the radiographer’s disposal of assessing image quality. The student should aim to produce a radiographic result which provides the necessary information under the prevailing viewing conditions. The importance of optimized and standardized viewing conditions should be stressed and the implications of non-optimized, non-standardized viewing conditions considered. The human element in the assessment of image quality should be dealt with at an elementary level sufficient for the student to gain a broad appreciation of the physiological and psychological aspects involved.

**(a) Radiographic illuminators**; single and banked illuminators, constant and variable intensity illuminators, illuminators with variable colour of illumination.

(b) Care and maintenance of equipment used for viewing radiographs.

(c) Consideration should be given to standardization of illumination and its importance, together with conditions necessary for the satisfactory viewing of radiographs based on the results of experiments which the student may carry out, designed to demonstrate subjectively the effects of variation in viewing conditions.

Image perception; contrast perception and image brightness, visual acuity, resolution and viewing distance, optical magnification and its effect on the perception of image detail, contrast and definition, colour vision and sensitivity, visual fatigue and its effect on image detail perception.

This should be taught at an elementary level sufficient to appreciate the basic concepts.

(*d) Methods and equipment for viewing miniature films including cine films*.

(Intra-departmental, intra-hospital and hospital to hospital video transmission of radiographic images. Advantages and limitations of such systems.)

**THE PROCESSING OF FILM MATERIALS**

Film processing techniques in both X-ray department and operating theatre should be considered, but whereas the student should have a thorough working knowledge of departmental methods, it is necessary only to be aware that these methods can be adapted if and when necessary for use in other areas such as an operating theatre. In addition, the student should be aware that an image intensification system is an alternative to the use of radiographic film in the operating theatre obviating the need for film processing facilities.

Most aspects of automatic processing should be covered in detail and while manual processing techniques should be appreciated, its treatment should be minor in comparison. The use of the automatic processor in partially or fully automated film handling systems should be considered.

(a) Processing Chemicals

Need for processing chemicals.

Steps and sequence in a typical film processing cycle; purpose of each step.

Types of developer and fixer and their application. Presentation of powder and liquid chemicals.

Replenisher/regenerator for developers and fixers.

Storage and shelf life of powder and liquid chemicals.

pH. Its meaning and importance in processing.

**(i.) X-ray developers and their replenishers/regenerators**

The functions of the developer and its associated replenisher/regenerator should be fully appreciated but only an elementary knowledge of the basic constituents and chemical processes involved is necessary.

Recommended standard development conditions. Time/temperature relation for standardized development.

Effects of variations in development conditions.

These should be related to a subjective assessment of image quality and objective assessment of image densities and density differences. The effects on the characteristic curve of such variation should also be considered.

Developer exhaustion and reasons for its occurrence.

Developer replenishment/regeneration methods in automatic and manual processing.

**(ii.) X-ray fixer and their replenishers/regenerators**

The functions of the fixer and its associated replenisher/regenerator should be fully appreciated. A knowledge of the chemical process involved is necessary for an understanding of silver recovery and the processes involved.

Fixing time required for different film materials; single and double bath fixing methods in manual processing.

Effect of temperature on fixing time. Fixer temperature relative to developer temperature. Clearing time, its determination and significance in manual processing.

Fixer exhaustion and reasons for its occurrence.

Fixer replenishment/regeneration methods in manual and automatic processing.

Effects of inadequate fixing in manual and automatic processors.

Importance of an adequate squeegee roller system (or draining time)relative to silver conservation.

**(iii)Rinsing, washing and drying**

Functions of rinsing and washing; methods employed. Alternative to rinsing in automatic roller processing. Wetting agents, their function and method of use in manual processing.

Function of drying; methods of drying manually processed film.

Effects of inadequate rinsing, Washing and drying.

**(b) Preparation of solutions**

Precautions in handling and preparing solutions, consideration being given to ventilation, correct clothing, respiratory and skin conditions and protection from personal injury.

Basic equipment required, suitable water supply and methods of preparation of solutions.

**Automatic processing**

**c) Steps and sequence of automatic processing**.

Purpose of each step.

(d) Operating and processor.

Film feed technique.

Checking temperatures and replenishment rates.

Cleaning routines, methods and reasons.

Layout of processing solution tanks. The processing cycle. Fixed and variable time cycles. Functions of the different sets of rollers.

Roller racks and their arrangement in the processing unit.

Control of film transport and total transport time.

Times and control of film transport times in the individual tanks.

Film transport time, its importance and relation to temperature.

Control of temperature and its importance.

Water supply and its control. The processor water system.

Processing solution recirculation systems and their importance.

Replenisher reservoirs, pumps and filters.

Location of replenisher reservoirs. Importance of correct replenishment rates.

Control of replenishment rates. Solution replenishment relative to film feed-in.

Economizer unit (standby unit).

Washing of the film. Hot air and infra red heater drying methods.

Processing roll film. Film leaders, leader tape.

Replenishment requirements in a large film auto-processor.

Automatic film feed-in-systems.

Position of the processor relative to the darkroom.

Protection of film from light exposure during processing.

Processors designed specifically for processing miniature roll film should be considered alongside the large film processors.

Care and maintenance of auto-processors. Solution precipitates and their effects.

Film faults due to inadequate care and maintenance of the auto-processor should be dealt with and an indication given as to their possible cure.

(The students should be familiar with currently available automatic processing units and their relative merits.)

**Manual processing**

(e). Technique for manual processing, processing sequence.

A simple standard unit should be considered with respect to layout of processing solution tanks and their contents for a logical processing sequence.

Comparison with automatic processor.

The standard processing cycle and permitted variations.

Tank capacities related to workload and required film immersion time.

Handling of films in the unit, reference being made to maximum film capacity and avoidance of film damage, and solution agitation and film agitation and their importance.

Use of water in the intermediate and final stages of chemical processing.

Emptying and cleaning of tanks.

Open and sealed water jackets.

Solution temperature and temperature control.

Tank covers including floating lids, the purpose and importance of which should be considered.

General cleanliness of the unit and its importance.

In situ silver recovery should be briefly dealt with, a fuller consideration being left to the section on silver recovery in general.

Consideration should be given to the maintenance and role of the manual processing unit when used as the only means of film processing and when used in conjunction with automatic processor(s).

(f). Film hangers: types, care and cleaning, use.

(g). Image quality control

This section requires reference to the use of sensitometric principles in a limited evaluation of the image quality of the processed film.

This information is to be used in the continuous assessment of processing.

Preparation and use of control films in manual and automatic processing.

Use of film manufacturers’ control films. Recorded information.

Frequency of testing. Storage of processed strips for comparative purposes.

Visual assessment of results by comparison.

Use of a densitometer in assessment of results.

Graphical representation of results.

Test sensitivity, evaluation of results and relation to radiographic image quality.

Effects of processing variations on results.

(Students should have detailed knowledge of image quality control systems, their limitations and the organization of such systems.}

**SILVER CONSERVATION AND RECOVERY**

Money obtained from the sale of recovered silver is an important source o revenue.

The method of recovery, the degree of expertise and the care taken will determine the quality and quantity of silver recovered. The student must be made aware of these facts and have a good working knowledge of the processes involved and how to control them.

The exposed and processed film as a source of silver and revenue should be considered and the student should be aware that even when silver recovery is not undertaken in a department, the waste fixer is a saleable item. Silver as a diminishing world resource should be discussed, with a view to developing practical methods of minimizing its use.

Practical methods of using silver economically.

The film and used fixer solution as sources of silver.

Methods of recovering silver from used fixer solution

**(i) Electrolysis**

Principles. Use of high and low current densities.

Factors affecting the percentage of silver recovered.

Estimation of silver content.

Required current density values relative to fixer type,

content and method used.

Sulphiding, cause, effect and prevention.

Recycling of fixer. Removal and collection of silver.

Economics of silver recovery.

**ii. Metallic replacement**

Principles. Importance of correct pH.

Solution flow rate.

Factors affecting the percentage of silver recovered.

Estimation of silver content of effluent and input.

Type of unit, its preparation and use.

Regulations relating to effluent.

Fire hazard.

Removal and handling of silver containing residue.

The relative advantages and disadvantages of each method should be appreciated and emphasis should be placed on the departmental use and control of at least one of the above techniques, together with care and maintenance of the equipment used.

(Students should be able to evaluate and compare the methods of silver recovery and should be aware of likely future trends.)

**THE X-RAY DARKROOM**

The darkroom should be considered with respect to both conventional techniques and the increasing use of ‘daylight’ systems.

(a) Relative position and dimensions. Entrance requirements.

Equipment and its arrangement. (The functional aspects should be considered in depth together with procedures undertaken in the darkroom). General darkrooms for automatic and/or manual processing should be considered together with specialized darkrooms required for a specific purpose.

Cassette hatches.

Cassette and film transport systems.

 (b) Reason for handling film in safe lighting.

Effect of white light on unprocessed film.

Measures adopted to provide light-proofing and chemical and radiation protection.

White lighting. Suitable light source. Switching arrangements.

Safe lighting; requirements relative to darkroom size and number of working points; safe lighting relative to spectral sensitivity of different film-types processed; types of safelights, light source and safelight filters - structure, functions, care and maintenance. Switching arrangements.

Darkroom colour scheme.

That the measures taken are effective should be demonstrated by testing procedures.

Testing safety of illumination.

Tests should cover single safelights and general safe lighting.

(c) The receiving and sorting room should be considered together with the darkrooms.

(d) Relevant aspects of ‘Health and Safety at Work’ Act.

Ambient temperature and ventilation.

Care and maintenance of equipment.

The planning, operational policies and management of processing facilities, equipment and staff in various sizes of department.

In-service training for processing technicians.

**DUPLICATION AND SUBTRACTION**

While a variety of film materials (and techniques) may be used for duplication and subtraction, the use of film material specifically designed for these procedures should be emphasized and the techniques using this film material considered in detail.

**(a) Duplicating Radiographs**

Required characteristics of the original film.

Equipment and method of use. Full-size and minified copies.

Film material.

Exposing light source, ultra violet and white light. Their effect on the characteristic curve of the film material used to be related to the required characteristics of the copy image.

Arrangement of films for exposure.

Use of copies for record purposes.

**(b) Photographic Subtraction**

Equipment. Method.

Film materials. Required image characteristics of the original film.

Exposure and processing requirements. Standardization.

**c. Digital Subtraction**

Digital image subtraction principles.

**IMAGING PRINCIPLES OF SPECIAL IMAGING TECHNIQUES**

This section covers macroradiography, stereoradiography, tomography and Xeroraiography. Applications should not be considered. It is the principles involved in obtaining the desired image which are important here.

**Macroradiography**

Imaging principles. The student should, given a value for magnification, be able to determine an appropriate focus-object distance and object-film distance, and image recording system consistent with required image quality.

The effects on image quality of variations in the factors relating to imaging should be fully considered including the acceptable maximum magnification factor for a given system.

**Stereoradiography**

Imaging principles.

The student should be able to determine, as a distance or an angle, the required tube shift for a known viewing distance to achieve a normal stereoscopic effect.

The effects of using a greater or lesser tube shift should also be appreciated together with the maximum tube shift beyond which the effect of depth cannot be achieved.

Viewing systems. Method of viewing. Faults due to incorrect viewing technique.

Identification of stereoradiographs.

**Tomography**

Imaging principles.

Effect on the image of variation in focus object distance, object film distance, exposure angle, relative fulcrum (pivot), tube movement pattern, and other contributing factors.

**Xeroradiography**

Principles. Equipment for plate cleaning and charging, and for processing the image

Image recording system. Preparation of the plate for exposure.

Method of use. Exposure requirements.

Processing and viewing the xeroradiograph.

A comparative study should be made of all imaging methods available.

**AUTOMATED FILM HANDLING SYSTEMS**

Partial and fully automated film handling systems should be considered. These should be dealt with in simple, general terms indicating the principles of operation and the relative advantages and disadvantages.

The role of these systems and their integration into the departmental system should be considered.

(a). Systems for automatic loading and unloading of conventional cassettes.

(b). Systems for automatic film feed into an automatic processor.

(c). Complete and integrated film handling systems.

Planning, operation policy and management of such systems and their effect on staffing levels.

**PHOTOFLUOROGRAPHY**

In addition to photofluorography, closed circuit television and videotape imaging should be dealt with in this section, emphasis being placed on the effective control of image quality. Comparisons should be made with other imaging systems and their resultant images (including fluoroscopy Without image intensification and closed circuit television) and possible applications considered from the point of view of the image quality required.

Students should have an opportunity of operating photofluorographic equipment including the handling of film magazines and the handling and processing of the film material. Resultant image quality should be considered together with factors affecting it.

(a) An understanding of the principles of photofluorography.

(b) Recording the Image

Minification and the minified image.

Resolution and its significance.

Cine cameras.

Frame speeds.

Cine fluorography with a cine pulse system.

Exposure requirements and selection of pulse width.

Film identification.

Cameras for single and rapid sequence exposure fluorography.

Frame speeds and exposure requirements.

Film formats.

(c) Kinescopy and the recording of the image.

Imaging with videotape. Storage, care and protection of videotapes.

**Radiographic Technique**

**Minimum number of teaching hours 200**

CONTENTS Page

Aims and Objectives

The Radiographic Image

Radiographic Protection

The Skeleton

Plain Radiography of the Viscera and Soft Tissue

Procedures which Involve the Use of Radiological Contrast Agents

Accident and Emergency Radiography

Gynaecological and Obstetric Radiography

Dental Radiography

Paediatric Radiography

Geriatric Radiography

Ward Radiography

Operating Theatre Radiography

Supplementary Diagnostic Procedures

**Aims & Objectives**

Student radiographers will be required during their training to achieve the following objectives:

l. To become proficient in performing, to diagnostically acceptable standards, the various

 practical procedures as set out in the following syllabus.

2. To be able to demonstrate the ability to care for the patients, whilst carrying out technical

 procedures.

3. To be able to demonstrate the ability to apply Radiation Protection and Health and Safety

 recommendations concerning patients and staff.

4. To be able to describe radiographic principles and procedures clearly, in accurate scientific

 language.

5. To be able to evaluate and compare the various procedures used in diagnostic radiography

 and in other diagnostic procedures with which a radiographer might be involved (including

 those which do not require the use of ionizing radiation).

6. To be able to describe and discuss recently-developed techniques and current trends.

7. To be able to describe and discuss the planning and management of radiographic services

 in all their aspects.

8. To be able to describe the ways in which good patient care and radiographic practice can

 be taught to staff and students and how new techniques may be introduced.

9. To be able to discuss the recording of data and the identification of patients’ films.

10. To be able to describe the factors to be taken into account in compiling “units of Work”

 and be able to discuss the use of these and other statistics in the planning and scheduling

 of work in an X-ray department.

11 To be able to discuss the use of control of resources within the department including

 selection recording and budgeting.

**THE RADIOGRAPHIC IMAGE**

Students should learn the principles of radiographic image by performing experiments with phantoms and analyzing the resulting radiographs.

1. **Shadow Formation**

a) Inter-relation of X-ray tube, object and film (or screen); direction and centring of the X-ray beam in relation to the object; magnification; distortion (elongation and foreshortening).

b) Two-dimensional limitations of the radiographic image; requirement for at least two complementary projections for full demonstration of an object.

Stereoradiography: principles, techniques of exposing films,methods of viewing films, applications of the technique.

1. **Unsharpness of the Image**

Students should learn, preferably by experiments with phantoms, the inter-relation of the three groups of factors. Here, in the context of Radiographic Technique, it is their influence upon the practical choice of exposure conditions, including the frequent need for compromise, which is

particularly relevant.

**a) Geometric Unsharpness**

Penumbra: its cause and control.

Effects upon penumbra of variations in focal spot-size, object-film distance and focus-film distance.

**b) Movement Unsharpness**

Necessity for clear communication between radiographer and patient. Use of immobilization devices. Use of intensifying screens. Selection of exposure factors and conditions to limit movement unsharpness.

Techniques (autotomographic) employing deliberate movement by the patient, to blur shadows of structures which otherwise would tend to obscure the object. `

**c) Photographic Unsharpness**

Effects upon the image of the use of different types of film/intensifying screen combinations and cassettes.

1. **Contrast of the Image**

a) Effects upon composition of emergent beam (transmitted through object) of variations in tube kilovoltage and in effective atomic number, density and thickness of the object.

Effects of different types of X-ray tube supply waveform and amount of primary beam filtration. Use of differential filters and graded intensifying screens.

b) Relative amounts and direction of scattered radiation at different primary radiation energies.

c) Control of Scattered Radiation

Limitation of scatter production by use of primary beam collimation and compression (tissue displacement).

Reduction of amount of scatter reaching film (or screen) by use of a secondary radiation grid or secondary radiation filter.

Function and use of an air gap.

1. **Exposure Factors**

Students will be require to discuss the principles of exposure factor selection for the projections and techniques listed in the syllabus, which will produce an image of the desire density and contrast and show minimal unsharpness.

The term “Exposure Factors" describes settings of k\/p, mA and exposure time (seconds), focus-film distance, focal spot size, type of film and (if used) type of intensifying screens and secondary radiation grid.

a) Operation of the controls and switches and the function of meters and other indicators commonly found on the control panel of an X-ray set.

b) Exposure procedure: sequence of selection factors, significance of percentage load indication, observation of meters.

c) Selection of exposure factors with regard to tube rating, degree of primary beam collimation and patient’s size and posture. Selection with regard to tube filtration and Waveform.

d) Use of automatic exposure timers: selection and positioning of dominant areas, preselection of appropriate densities, precautions during use.

Limitations of automatic exposure control.

e) Alterations of usual exposure factors to allow for changes in object density as a consequence of pathological conditions or the application of plaster of Paris.

f) Exposure factors for tomography: variation of exposure angle and speed of tube/film movement; multi-section techniques exposures.

g) Exposure factors for rapid serial programmes and cineradiography; use, in their planning, of tube rating charts and anode heating/cooling charts.

1. **Tomography**

a) General principles of tomography, including zonography; variation of height and thickness of section. Practical use of tomographic attachments and specialized units. Experiment proof of the principles of tomography. Simultaneous multisection techniques: relative advantageous and limitations.

b) Applications of tomography and zonography to examinations of the skeleton and the respiratory, biliary and urinary tracts.

c) Practical procedure: determination of pivot height section thickness, spacing of sections.

1. **Image Definition**

Students should learn to correlate all the factors which contribute to the definition of the radiographic image - i.e. those which influence the perception of either its contrast or its unsharpness. This matter will also be considered in the photography section of the syllabus; the emphasis and approach with respect to radiographic technique will be one of practical considerations at the time when a radiographic examination is being carried out.

System of quality control in an X-ray department; maintenance of standards.

**RADIATION PROTECTION**

Throughout their training, students must study the current Codes of Practice and regulations in respect of radiation safety and apply their recommendations to all practical procedures. An increase in knowledge about the practical application of radiation protection measures will be expected to accompany the student’s widening experience of radiographic techniques.

The points which fall completely within the radiographer’s control are especially important: e.g. reference to previous X-ray examinations (reports, radiographs and exposure factors), application of the 10-day rule, use of fast photographic materials, primary beam collimation, use of gonad shields and other protective accessories, recording of exposure factors for future reference.

The application of protection measures will be emphasized during (i) examination of children and pregnant women, (ii) examinations which involve several exposures - either in rapid sequence or repeated at intervals during a period of medical treatment 4 and (iii) examinations which involve exposure of radio-sensitive areas. (See also - Physics Syllabus ~ Section ‘Radiation Protection’)

Formulation of local Departmental Rules for Radiation Protection; monitoring of staff and environment (organizational aspect of); responsibilities of a Radiation Safety Officer; planning and maintaining of radiation protection measures within an X-ray Department.

**THE SKELETON**

Students are required to be able to carry out an examination to demonstrate each of the anatomical parts listed below in circumstances of traumatic pathological and congenital lesions.

Teachers are advised that although knowledge of techniques practiced locally may seem to be of most value to the student a range of parallel techniques may also produce satisfactory results. The student may be required to show a knowledge of the principles of such alternative techniques both at examination or, after qualification, when appointed to a post in an unfamiliar department

A radiographic technique involves the following points.

identification and preparation of the patient;

selection of appropriate X-ray equipment and suitable photographic materials;

positioning of patient and film;

direction and centring of the X-ray beam ;

selection of suitable exposure factors;

radiation protection;

after-care of the patients ;

documentation.

1. **Upper limb**

fingers, thumb, hand, wrist, joint, forearm, elbow, humerus, carpal tunnel, scaphoid bone injuries, radioulnar joints, head of radius, ulnar groove, bicipital groove.

**(b) Shoulder girdle and thorax**

shoulder joint, clavicle, scapula, ribs, acromioclavicular joints, sternum, sterno-clavicular joints,

demonstrations of tendon insertions in humeral tuberosities.

**(c) Lower limb**

whole foot, individual toes, forefoot, sesamoid bones, calcaneus; ankle joint, sub-talar joints, tibia and fibula, proximal tibiofibular joint, knee joint, patella, intercondylar notch, ligaments of ankle

and knee joints, lower two-thirds of femur, upper third of femur and hip joint, neck of femur.

**(d) Pelvic girdle**

Whole pelvis, sacrum, coccyx, iliac bones, sypmphysis pubis, acetabulum, sacro-illiac joints

**(e) Vertebral column**

cervical, cervicothoracic, thoracic, lumbar and lumbosacral regions, atlanto-occipital articulations, cervical ribs.

**(f) Skull**

cranial vault, base of skull (whole), mandible, sellaturcica, zygomatic arches, nasal bones.paranasal air sinuses, facial bones, petrous and mastoid parts of temporal bone, optic canals, temporo- mandibular joints, jugular foramina.

**(g) Skeletal surveys**

**PLAIN RADIOGRAPHY OF THE VISCERA AND SOFT TISSUE**

Students are required to be able to carry out techniques to demonstrate the non-skeletal parts of the body: the viscera and other soft tissues, pathological calcifications and intracavitary fluid levels.

A technique includes:

identification and preparation of the patient;

selection of appropriate photographic materials, X-ray equipment and accessories;

positioning of patient and film;

direction and centring of X-ray beam; '

exposure factors; '

radiation protection;

after-care of the patient;

documentation.

(a) lungs and Pleura (normal)

lungs and pleura (pathological conditions); larynx, trachea, post-nasal airways; demonstration of inhaled foreign bodies; use of respiratory maneuvers.

(b) abdominal and Pelvic contents

urinary tract

biliary tract;

gastrointestinal tract

demonstration of gastro-intestinal obstruction and perforation; calcification in wall of abdominal aorta and other main vessels.

(c) demonstration of swallowed foreign bodies.

(d) demonstration of foreign bodies; calcifications in the limbs.

(e) salivary glands.

(f) neck and thoracic inlet

(g) calcified pineal gland: its demonstration and significance.

(h) heart (oblique projections) and other mediastinal structures

(i) localization of sealed radioactive sources.

Localization of Foreign Bodies.

*(Use of Xeroradiography.*

*Stereotaxis.)*

**Procedures which involve the use of radio logical contrast agents**

Student radiographers will be required to carry Out the radiographic techniques of the examinations included in subsections 2 and 3. Practical experience of the more complicated procedures (subsections 4, 5 and 6) may be restricted but students will be expected to be able to describe the technical and physiological principles involved and the main practical points, as indicated.

The projections used will be mainly those covered by the previous sections.

**l . Contrast agents**

(a) Principles of the use of gases and opaque agents; relationship of X-ray transmission to the effective atomic number and density of the agent.

Safety and functional requirements of a contrast agent.

(b) Barium sulphate preparations: acqueous suspensions and paste; additives - e.g. for flavouring or colonic activation; combination with gas under pressure. Applications of the various forms of preparation.

(c) Iodine-containing preparations: organic iodine Compounds, solutions for intravenous infusion, iodised oils. Iodine content (nomenclature of proprietary agents), viscosity, recommended doses and applications of the various forms of agent.

(d). Allergies: tests, precautions and signs of allergic and other reactions to opaque agents. Treatment in the event of a reaction, including resuscitation procedure and use of drugs.

e) Gases: air, oxygen, carbon dioxide, nitrous oxide; their functions and applications.

Methods of introduction and precautions in their use.

*(Students will be required to state those medical conditions which have an influence on the choice of radiographic examinations or their content and to show an ability to evaluatethe different examinations as alternative diagnostic investigations of the patient, in a particular case.*

*Students shall be required to comment on the choice of radiographic examinations or their content where the medical treatment and management of the patient may have an influence, to discuss the care of the patient during the time spent in the X-ray department and to describe the relevant action to be taken in the case of a deterioration in the patient’s condition.*

*They will be required to show a greater ability to differentiate between normal and abnormal radiographic appearances, particularly where this will indicate a modification to the radiographic techniques being used, the need for a supplementary examination or a change in thetechnique of patient care and management.*

*Students will be able to evaluate the various contrast agents suitable for a given examination, and their methods of introduction)*

**2. Oral Cholecystography**

(a). Anatomy and physiology of the biliary tract.

1. Clinical indications and contra-indications.
2. Importance of plain radiography; types of gall stones; differentiation between biliary calculi and other calcifications within the abdomen.

(d) Types of contrast agent: precautions, dosage, ingestion; physiological processes leading to concentration of the opaque agent in the gall bladder.

Preparation of the patient, including diet restrictions.

(e) Typical programme of films, related to the time of ingestion of the agent.

Programme variations caused by delayed concentration or other abnormality.

Techniques to demonstrate gall bladder contraction.

Radiation protection.

(f) After-care of the patient.

**3. Excretion urography, intravenous cholangiography, lymphography**

The following considerations apply to all these examinations. Additional points are given under the separate headings.

(i). anatomy of the system

(ii) clinical indications and contra-indications;

(iii) physiological processes by which the tract is outlined by the opaque agent;

opaque agents available and their doses;

requirements for sterile injection;

methods of introducing the opaque agent and maximizing its effect.

(iv) preparation of the patient;

(V) typical programme of films: projections and timing (post injection);

radiographic appearances of normal and abnormal pathological conditions;

additional techniques (non-routine) which can be used to demonstrate particular pathological conditions;

radiation protection.

(vi) care of the patient during and after the examination.

***Excretion Urography***

Single injection and infusion techniques.

***Lymphography***

Use of a dye to colour the lymph capillaries;

types of injection apparatus;

importance of this technique with regard to radiotherapy

***Intravenous Cholangiography***

Single injection and infusion techniques.

1. **Sialography, Dacryocystography, Arthrography**

The following considerations apply to all these examinations. Additional points are given under the separate headings.

(i) anatomy and physiology of the area concerned;

(ii) clinical indications and contra-indications;

(iii) types of contrast agents and amount used;

 requirements for sterile injection;

(iv) preparation of the patient;

(v) outline of injection procedure;

 techniques for radiographic projections;

 radiographic appearances of normal and abnormal pathological conditions;

 management of the patient,

 radiation protection;

vi) after-care of the patient;

**Sialography**

**Dacryocystography**

 use of macroradiographic technique

**Arthrography**

 combined use of positive and negative agents

1. **Barium swallow, meal and enema, Retrograde pyelography, T –tube cholangiography, bronchography, urethrography, myelography, ventriculograhy, encephalography, sinography, fistulography**

These examinations differ in he frequency of their occurrence: opportunities to participate in some of the procedures listed may be arrange at any time during the training course but are likely to be of more benefit to senior students.

For all these examinations, the student should be able to describe:

(i) anatomy and physiology of the system or area being examined;

(ii) clinical indications and contra-indications;

(iii) types of contrast agent available and in current use;

 quantity of agent used and method of introduction;

(iv) preparation and care of the equipment and accessories;

(v) preparation of the patient;

(vi) outline of radiological procedure;

 the radiographer’s role in the team, with medical and nursing staff;

 control of radiographic equipment;

 control of fluoroscopic equipment, including image intensification and television system;

 radiation protection of patient and staff;

 general management of patient before, during and after the examination;

(vii) after-care of the patient

(viii) radiographic appearances of normal and abnormal pathologicalconditions.

***Barium swallow, meal and enema***

 Use of all forms of barium sulphate and other opaque agents;

 double contrast techniques.

***Bronchography***

Theatre and department procedures.

***Urethrography***

Ascending examination of the urethra

***Retrograde pyelography***

 Theatre and department procedures

Myelography and Radioculography

***Ventriculography***

***Encephalography***

***T-tube cholangiography***

***Sinography***

***Fistulography***

***Discography.***

***Retroperitoneal gas insufflation.***

1. **Arteriography, venography, cystography**

For all these examinations, the student should be able to describe:

(i) anatomy and physiology of the system or area being examined;

(ii) clinical indications and contra-indications;

(iii) types of contrast agent Available and quantities used;

(iv) preparation and care of equipment and accessories;

(v) preparation of the patient;

(vi) outline of radiological procedure, including introduction of contrast medium;

(vii) the radiographer’s role in he team, with medical and nursing staff

 Control of radiographic equipment, including serial film changer and cinefluorographic

 system; exposure factors for serial programmes;

 control of fluoroscopic equipment, including image intensification, television system and

 videotape recorder;

 procedures for radiographic subtraction;

 radiation protection of patient and staff;

 general management of patient before, during and after the examination;

(viii) radiographic appearances of normal and abnormal pathological conditions.

***Arteriography***

Abdominal, peripheral, cerebral, cardiac;

***Venography***

abdominal, peripheral, splenoportal;

***Cystography***

micturition studies.

(Students should be able to compare and discuss the various techniques and the methods of recording the image and to describe variations of the procedure in individual cases.)

**Accident and emergency Radiography**

Having learned the radiographic techniques for demonstration of the skeleton and the viscera, students must gain experience in performing and be able to describe examinations on patients who may be badly injured, shocked, paralyzed, unconscious, receiving intravenous drip infusions, immobilized with limbs splinted or on traction.

Students should be able to modify radiographic techniques to suit the circumstances. Considerations include:

(i) Selection, of suitable X-ray equipment and photographic materials consistent with the

 patient’s condition;

(ii) Operation of special accident equipment;

(iii) Selection of suitable radiographic projections and determination of best order in which

 these should be taken to demonstrate the patient’s condition

(iv) Modification to routine positioning technique, to accommodate the patient’s condition;

 Modifications to routine positioning of X-ray tube and film;

 Modifications to routine exposure factors and radiation protection measures

 necessitated by the patient’s condition;

(V) Care of the patient and liaison with medical and nursing staff simultaneously involved

 with the patient,

During the training, there will be a gradual increase, from minor to severe, in the nature and extent of the injuries and acute conditions which the student will radiograph, either without aid or as an assistant:

(a) limb fractures;

(b) gastro-intestinal obstruction and perforation;

(c) fractures of thoracic cage;

(d) lung collapse;

(e) fractures of skull, spine and pelvis;

(f) special medico-legal implications.

(The student must be able to describe and discuss the planning and management of facilities, equipment and staff, operational policies, and the planning and control of a Major Accident procedure.)

**GYNAECOLOGICAL AND OBSTETRIC RADIOGRAPHY**

The special nature of patent care, both psychological and physical, is to be considered. Students must demonstrate an appreciation of the patient’s need for reassurance and privacy.

***(a) Mammography***

(i)Anatomy and physiology of the female breast.

(ii)Requirements regarding the wavelengths of radiation appropriate to this examination.

(iii)Equipment suitable for generating X-radiation of these wavelengths.

(iv)Image recording media-conventional and xerographic.

(V)Accessories for immobilization and identification.

(Vi)Positioning and management of the patient; direction and centering of X-ray beams; exposure factors; radiation protection.

***(b) Hysterosalpingography***

(i)Anatomy and physiology of the female reproductive system.

(ii)Clinical indications and contra-indications

(iii)Opaque agents and amounts used for this examination; requirements for the sterile injection; accessory equipment required.

(iv)Preparation of the patient.

(V)Outline of radiographic procedure; control of fluoroscopic equipment; radiation protection; general management of the patient during examination.

(vi)After-care of the patient.

(vii)Radiographic appearances of normal and abnormal pathological conditions.

***(c) The abdomen during pregnancy***

Conventional x-ray techniques for :

(i) demonstrating the foetus,

(ii) pelvimetry,

(iii) placentography;

including equipment and accessories necessary for these techniques; importance of radiation protection for mother and foetus, management of the patient.

Obstetrical terms in common clinical use.

***(d) Ultrasound***

Students will be expected to demonstrate outline knowledge of the use of ultrasonic techniques in obstetrics.

Students are required to be able to discuss the advantages and limitations of ultrasonic techniques compared with conventional radiography.

**Dental radiography**

The student must gain practical experience in and be able to describe the techniques listed below:

(a) operation of specialized dental X-ray equipment.

(b) techniques for intra-oral examinations; use of dental, occlusal and bite-wing films; radiation protection; identification and mounting of films.

(c) extra-oral techniques for demonstration of position of teeth.

(d) orthopantomography.

(e) orthodontic and faciomaxillary techniques.

(The student must be able to discuss both the role of a general X-ray department in serving a dental clinic, and the planning and operation of a specialized Dental X-ray department.)

**PAEDIATRIC RADIOGRAPHY**

The special care required when receiving children for X-ray examination must be considered. Students should demonstrate an appreciation of the apprehension usually felt by children and their parents and allow for its consequences by modifying their techniques.

Students should gain experience in the use of the various aids available which encourage the child’s co-operation or immobilization, and which remove uncertainties from the selection of exposure factors.

The importance of radiation protection for the patient and others must be stressed.

Students should be able to describe and demonstrate the modified “adult” techniques and also the special techniques peculiar to children.

**for example:**

demonstration of

imperforate anus,

congenital dislocation of hips,

oesophageal atresia,

scoliosis,

pesplanus and congenital talipes,

intussusception;

leg length measurement;

intramuscular injection of urographic opaque agents, and use of hyalase;

non-accidental trauma (“battered baby” syndrome);

assessment of bone age;

methods of phasing the exposure to the respiratory cycle;

problems relating to radiography of babies in incubators.

(Students must be able to discuss the special needs of both patient and radiographer when planning and equipping a room designated for paediatric radiography.)

**GERIATRIC RADIOGRAPHY**

The student should be able to demonstrate an awareness of the psychological and physical changes which occur with ageing and which require a particular approach by the radiographer to the patient.

The student is required to demonstrate an appreciation of the modification to routine techniques which are necessary when the patients are elderly and infirm.

Experience should be gained in the use of, and students should be able to describe, the various accessories and pieces of equipment designed to increase the patient’s comfort, to help with support and immobilization and to enable standardized projections to be taken with the patient in an unconventional position.

The student should be able to demonstrate an awareness of the effects of the ageing processes upon radiographic appearances, including adjustment of exposure factors to compensate for variations in the density of skeletal and other tissues.

(Students must be able to discuss the special needs of both patient and radiographer when planning and equipping a room designed for the examination of geriatric patients.}

**WARD RADIOGRAPHY**

Students are required to be able to demonstrate and describe the following features of ward radiography.

l. Ward etiquette and procedure - the students having a period of first-hand experience, arranged for this purpose.

2. The various ward radiographic techniques used - which may be covered at any time during the students’ training but preferably after they have become familiar with the equivalent departmental procedure and with the nursing care of the patient in bed, including patients receiving oxygen

therapy, intravenous infusions and with limbs on traction.

3. The safe operation of all mobile and portable equipment.

4. Skilled and efficient procedures, including management of all equipment and accessories, patient handling and the rapid production of processed radiographs.

5. Protection of the patient, other ward patients and staff.

6. The more specialized and demanding techniques of examining patients in an intensive care unit, when the student has gained proficiency in the conventional ward techniques.

(Students must be able to discuss the planning of a ward radiographic service, including the special needs of an intensive care unit. Candidates must be able to compare the capabilities of the various types of mobile and portable equipment, and to describe the indications for, use and limitations of mobile fluoroscopy equipment.)

**OPERATING THEATRE RADIOGRAPHY**

Students are required to be able lo demonstrate and describe the following features of operating theatre radiography:

(i) strict observation of asepsis;

(ii) careful and safe operation of all X-ray equipment including mobile fluoroscopic equipment;

(iii) radiation protection of patient and all theatre personnel;

(iv) rapid provision of a radiographic image.

The various techniques, including preparation and testing of equipment may be covered at any time during their training but students should preferably have had previous experience of the equivalent departmental techniques.

operative cholangiography;

direct renal pyelography and examination of kidney during renal surgery;

bronchography;

hysterosalpingography;

orthopaedic procedures, - e.g. fixation of fractured neck of femur;

post-operative chest.

(Students must be able to discuss the planning of a theatre radiographic service.

Students must be able to compare the capabilities of the various types of equipment and to describe the indications for, use and limitations, of mobile fluoroscopy equipment.)

**SUPPLEMENTARY DIAGNOSTIC PROCEDURES**

Students will be required to describe in outline only the principles of the following investigations, and their performance.

Computerized Tomography

(diagnostic use of Ultrasound)

Diagnostic use of Radionuclides

Thermography

Bone mineralogy.

Magnetic Resonance Imaging

(Students may be expected to have had some experience of these techniques and be able to assess their value in comparison with conventional radiological procedures.)

**RADIOTHERAPY PHYSICS AND EQUIPMENT**

**CONTENTS**

Aims and Objectives

Aims and Objectives

Atomic Structure and Radioactivity, Radiation Physics

Equipment for Production of Radiation Beams for Therapeutic Purposes ..

Interaction of Radiation Beams with Matter

Measurement of Radiation Beams

Practical Dosage Measurement and Calculations for X and Gamma Rays and Electron Beams

Radiographic Imaging for Radiation Beam Therapy

Technical Aspects of Radiation Beam Therapy

Technical Aspects of the Use of Small Sealed Radionuclides in Radiotherapy. Technical

Aspects of the Use of Unsealed Radionuclides in Therapy and Diagnosis

Radiation Protection

General Safety

**Suggested number of teaching hours – 100**

**Aims an objectives**

The aim of this syllabus is to ensure that the student:-

l. is able to discuss and describe, orally and in writing, in a scientific language the use of the application of ionizing radiations to the patient.

2. understands the principles of radiation dosimetry as applied to the patient

a) for the treatment of malignant and non-malignant disease;

b) to be able to interpret and assess the efficiency and accuracy of a prescribed dose distribution;

c) to be able to produce a suitable plan for the treatment of a lesion according to the prescription of the radiotherapist.

3. has a clear and simple understanding of the construction and function of commonly used treatment units, simulators, and all accessory equipment in order to be able to:

a) operate the equipment safely and with confidence;

b) recognize faults in the equipment;

c) recognize, interpret and draw block circuit diagrams of the equipment or parts of the equipment.

4. has a theoretical knowledge of the production of sealed and unsealed radionuclides used in medicine and has a practical knowledge of their use so as to be able to handle them with due precaution in relation to radiation protection of staff and patients.

5. appreciates radiation hazards and health and safety recommendations in relation to staff and patients associated with the application of ionizing radiations.

6. *Equipment for Production o f Radiations Beams for Therapeutic Purposes*

demonstrate a knowledge of different types of equipment and their design.

demonstrate a knowledge of different types of beam defining and collimation systems and safety devices and be able to discuss and evaluate the different types.

7. *X-Ray Therapy Beams up to 500kVp*

be able to discuss the problems of insulation and cooling of this type of equipment.

8. *Megavoltage, X-ray Therapy and Electron Beam.*

appreciate the problems of using equipment in two modalities and be able to discuss the problems involved.

9. *Gamma-Ray Beam Units*

demonstrate a knowledge of and be able to discuss the special problems presented by this type of equipment including radiation protection and training personnel.

10*. Neutron Beam Units*

demonstrate a knowledge of the various equipment currently available and be able to discuss the use of the various types.

11. *Atomic Structure and Radioactivity.*

Demonstrate a more detailed knowledge of the various radionuclides used in medicine in particular circumstances.

12 *Radiation Physics*

discuss the factors affecting variation of X-ray production and evaluate the effect on radiotherapy technique.

The student will be required to revise some subjects included in the Physics section of the syllabus to provide background knowledge to emphasize the relevant practical applications. This applies to some topics in the following sections.

ATOMIC STRUCTURE AND RADIOACTIVITY

RADIATION PHYSICS

EQUIPMENT FOR PRODUCTION OF RADIATION BEAMS FOR THERAPEUTIC PURPOSES - X-Ray Therapy Beams up to 500k Vp

INTERACTION OF RADIATION BEAMS WITH MATTER

MEASUREMENT OF RADIATION BEAMS

The suggested minimum number of teaching hours is 100. Additional tutorials will be required and approximately 25 hours should be devoted to practical work.

The practical aspects of the subject must be emphasised.

Some sections of the syllabus have been divided into subsections. In each case the main heading of each section should be referred to when teaching thetopics in the subsection.

It is essential that the student should participate in practical experiments and project work Whenever possible.

In the right-hand column some examples of practical work are shown where appropriate to the theoretical part of the syllabus.

The student should have the opportunity to visit other radiotherapy centres and places of particular interest e.g. research laboratories, radiation protection service laboratories, where possible.

ATOMIC STRUCTURE AND RADIOACTIVITY

Atomic mass and number

Radioactivity, radioactive decay, half-life, radioactive equilibrium, units of activity.

(Measurements to demonstrate activity, half life and tenth life period)

Decay schemes: alpha, electron and positron emission, electron capture, gamma emission, annihilation radiations, isomeric transition.(Examples of various emitters.)

Properties of radioactive emissions. \_

Radium and its daughter nuclides.

Artificial radionuclides and their production.

Qualitative description of the structure and functioning of

a) Radionuclide generators.

b) Nuclear reactor and cyclotron.

Radionuclides used in medicine.

Exposure rate constant. Units of measurement.

**RADIATION PHYSICS**

Electromagnetic radiation, waves and quanta.

General properties of electromagnetic radiation.

Intensity and quality. `

Continuous, line and characteristic spectra.

Effects of variation of tube voltage, current, filtration, H.T. waveform and target material on X-ray production.

**EQUIPMENT FOR PRODUCTION OF RADIATION BEAMS FOR THERAPEUTIC PURPOSES**

**X-ray therapy beams up to 500 kVp**

X-ray tube design. Target design. Spatial distribution of radiation around the focal spot.

High tension circuits. Filament circuits.

Insulation and cooling.

Demonstrations with dismantled X-ray tubes including cooling

arrangements.

Main voltage compensation. Control of tube voltage. Practical demonstrations of treatment units explaining meters and controls.

Beam defining systems and collimation.

Types of mountings and movement.

Information displayed at the control panel.

Safety devices and interlocks. Performing checks of interlock apparatus - e.g. Wedge banks, treatment room entrances, control panels

**Mega-voltage, X-ray Therapy and Electron Beam.**

Basic principles of the linear accelerator for the production of X-ray and electron beams, with particular emphasis upon: target design, spatial distribution of radiation around the focal spot; primary and secondary collimation; position of beam flattening filters; optical range finders and optical beam defining systems.

Opportunity to see unit dismantled during servicing, demonstration of flattening filter and target for example.

Types of mountings and movements. Practical demonstrations of the treatment units explaining meters and controls.

Principles of conversion for electron production; scattering foils.

Electron beam collimators.

Information displayed at the control panel.

Safety devices and interlocks. Performing checks of interlock apparatus.

Qualitative description of the structure and function of the betatron

**Gamma Ray Beam Units**

Design of gamma ray source, spatial distribution of radiation around the source.

Construction of source housing. On/Off mechanisms, to include source transport and shutter systems.

Primary and secondary collimation, including penumbra trimmers.

Optical range finders. Optical beam defining systems.

Types of mountings and movements.

Information displayed at the control panel.

Safety devices and interlocks.

**Neutron Beam Units**

Basic principles of the production of fast neutron beams.

**Accessory Equipment**

Design and attachment of ;- a) beam direction devices

 b) beam modification devices

**INTERACTION OF RADIATION BEAM WITH MATTER**

Photo-electric absorption; Compton scattering; pair production.

Dependence upon the nature and atomic number of the absorber and upon radiation energy.

Linear energy transfer.

Range of secondary electrons and electron build-up.

Principles of filtration, beam definition and radiation protective materials.

Transmission through body tissues of homogenous and heterogenous radiation beams.

Attenuation of radiation.

The significance of scattered radiation with regard to patient dose.

Principles of phantom and bolus materials.

Student should be able to demonstrate a detailed knowledge and discuss the relevance to radiotherapy technique.

**MEASUREMENT OF RADIATION BEAMS**

Units of measurement

Intensity. Quality. Half-value layer and its measurement. ( Measurement of half-value layers).

Quality ; (beam hardening) filters and filtration.

Methods of measurement; ionization; photographic scintillation; calorimetric; thermo luminescent; chemical; solid state detectors. » '

Dose and dose rate meters to include ionisation chambers, Geiger-Muller and scintillation counters and thermoluminescent dosemeters. Their relative advantages and their use.

(Demonstrations using the various methods where possible)

(The student should be able to demonstrate a detailed knowledge of the methods available and be able to discuss and evaluate the relative merits of a particular method in a specific situation.)

Practical Dosage Measurement and Calculations for X and Gamma Rays and Electron beams

Radiation output measurement to include full calibration and regular output checks.

Take part in calibration of various treatment units and where possible beam alignment and flatness tests.

Checking procedures for beam alignment, beam flatness and beam energy.

Variation of dose-rate across the beam in air.

Energy absorption in body tissues and its effect upon depth dose.

Air, surface and depth doses; factors affecting them.

Back scatter factor measurements.

Isodose curves: their measurement, effect of focal spot or source size.

Isodose curve measurements using end on films. Demonstration of isodose plotter where possible.

Penumbra, factors affecting penumbra. Measurement of penumbra using radiographs.

Phantoms. Phantom materials. Bolus materials.

Treatment dose calculations including factors used to calculate daily treatment time and monitor dose.

Practical examples of dose calculations using various factors.

Definitions of; maximum, minimum, mean, modal, tumour and integral dose.

Acceptance tests; parameters checked when new equipment is commissioned.

(The student should be able to demonstrate a more detailed knowledge and where possible gain practical experience in order to be able to discuss and evaluate the various methods and appreciate their relevance to radiotherapy technique.)

Radiographic imaging for radiation beam therapy

The structure of the film. Various types of film and their use.

Principles of sensitometry.

Common film faults.

Film envelopes, cassettes and screens. Choice of phosphors.

Basic principles of processing. Types of processors.

The production of the visible image at all radiation energies.

Physical principles of contrast media.

Factors controlling definition and contrast. General understanding of the alternative uses of diagnostic units, therapeutic units and simulators for the production of visible images for radiotherapy.

Exposure factors for diagnostic and therapeutic photon energies.

Magnification factors, particularly in relation to the positioning of the film for localisation and beam verification.

Principles of the simulator: the X-ray tube, image intensifier, television monitor, mountings and movements, the control panel.

*(Practical demonstrations, including processing and production of Film faults.*

*Demonstrations to show how various factors affect the quality of resultant radiograph. Magnification factors. )*

Technical aspects of radiation beam therapy

Methods of tumour localization. The use of simulators.

Manual treatment planning of dose distributions to include single, parallel opposed and multifield treatments including the use of wedged and compensated fields.

Practical demonstration using suitable phantoms.

The use of simulators. The use of computers.

Beam direction devices, including: pointers mechanical and optical, pin and arc; isocentric mountings and treatment shells.

Demonstrations of the various methods available.

Wedge filters. Compensating filters. Beam flattening filters. Demonstrations using end on films.

Methods of modifying the field size and shape including the various materials used e.g. lead cut outs.

Physical principles of moving beam therapy.

Special aspects of radiotherapy: electron beams, fast neutron beams.

(The student should be able to demonstrate a knowledge of :

Several methods of tumour location and localization including computerized axial tomography and be able to discuss and evaluate the methods.

Various types of simulators currently available and be able to discuss their use in particular to radiotherapy planning, patient treatment, accuracy of set-up and departmental organization.

The various methods of treatment planning available, and be able to discuss the use of computers, beam direction devices, use of compensators and methods of modifying field size and shape.

The special problems encountered when using electron and fast neutron beams and their effect on departmental organization.)

Technical Aspects of the use of small sealed Radionuclides in Radiotherapy

Construction, measurement , testing and properties

Dose calculations. Practical examples to calculate dose levels.

Physical principles of applicators, moulds and implants. Practical experience with dummy applicators to develop techniques

Physical principles of after loading techniques.

Beta-ray therapy. Measurement of beta-ray dose.

Technical aspects of the use of unsealed radionuclides in therapy and diagnosis

Physical principles of the clinical use of unsealed radioactive substances.

Organ imaging and uptake tests.

Radiopharmaceuticals, their application and handling.

Principles of tracer and therapy doses.

Radiation detectors, scintillation and Geiger-Muller counters.

Dose calculations. Practical dose calculations.

Basic principles of rectilinear scanners and gamma cameras.

Radiation Protection

Relevant protection recommendations and current Codes of Practice.

Biological effects.

Protective materials in common use.

Design and construction of rooms and radiation equipment in

treatment area.

Leak tests for gamma ray beam units. Monitoring the stray radiation.

Personnel monitoring, environmental surveys, film badges, condenser chambers, thermoluminescent dose-meters, and environmental survey meters.

(Visit to personnel monitoring laboratory for practical demonstrations)

Care and custody of small radionuclide sources.

Precautions to be taken in the use and dispensing of unsealed radionuclides. Long and short-term decontamination methods.

Radiation emergencies.

(The student should be able to:

Demonstrate a knowledge of relevant legislation and documentation.

Define the duties of a \_Radiation Safety Officer.

Formulate local rules for radiation protection.

Formulate work drills and routine to ensure safe operation of equipment.

Produce plans and designs for new departments and/ or treatment rooms with particular reference to radiation protection.

Organize personnel monitoring and maintain radiation protective measures within the department.

Demonstrate a knowledge of various methods of care and custody of small sealed radionuclides in order to discuss and evaluate methods)

General safety

Relevant recommendations and current codes of practice.

Hazards – mechanical and electrical.

Acceptance tests on new equipment. Routine electrical and mechanical checks. Reporting of faults.

Special aspects of equipment and departmental design.

Emergencies - e.g. electrical and fire.

(The student should be able to demonstrate an understanding of relevant documentation and legislation)

Principles of Radiotherapy and Oncology

**Number of teaching Hours including tutorials and demonstrations = 100**

CONTENTS

Aims and Objectives

Elementary Pathology

Biological Effects of Radiation and Chemotherapeutic Agents

Principles Affecting the Treatment of Benign Conditions, Treatment of Malignant Disease,

Treatment Modalities, Factors Affecting Choice of Treatment

Choice of Radiation, Method of Radiation Treatment

Factors Affecting Tumour Dose

AIMS AND OBJECTIVES

1. The student should be equipped the with knowledge and understanding of :

1. l. The various diseases encompassed by the specialty of radiotherapy.
2. The behaviour of various radiations in tissues.
3. The principles underlying choice of treatment.
4. The principles of dosage and factors affecting tumour dose. -

(Oncology in general should be studied at a level such that the student can understand radiotherapy techniques and supportive therapy. The student must be able to describe the role of surgery, radiotherapy, chemotherapy, hormone therapy or any combination of these, and so demonstrate his or her understanding of the role of the therapeutic radiographer in the treatment of disease.)

2. To be able to demonstrate understanding of the principles which influence the choice of different treatment techniques in the management of patients with malignant disease.

Elementary Pathology

The student should be able to define terms, recognize signs, symptoms and characteristics in given examples, and apply this knowledge to specific tumours arising in a patient. The student must relate the main features of the pathology to the management of patients with tumours.

The student should recall the salient features of :-

l. Inflammatory processes; definitions and examples.

2. Tumours.

(a) Definitions, formation of tumours, characteristics of benign and malignant tumours.

(b) Types of benign and malignant tumours occurring in - e.g. epithelial tissues, connective tissues, etc.

(c) Classification and general pathology of each type of tumour.

(d) Tumours of childhood.

3. General methods of spread of malignant disease.

4. Grading, staging (including TNM) incidence, epidemiology and aetiology of malignant

 disease.

5. Biopsy; principles, purpose and methods.

6. Haematology.

The normal differential blood count.

Recognize and appreciate the significance of change occurring in the cellular composition of the blood in malignant conditions:-

e.g. leukaemia

 polycythaemia -

 myeloma

 reticuloses

Describe the effects of radiation on the cellular composition of the blood.

7. Endocrinology.

Describe the tumours of the endocrine glands.

Have a knowledge of endocrine balance in malignant disease.

Biological effects of radiation and Chemotherapeutic Agents

The student should demonstrate knowledge of the behaviour of various radiations in tissues, the effect on the cell and on the body as a whole. He or she should have a general understanding of

the importance of Linear Energy Transfer and Relative Biological Effectiveness. In addition the student should be able to list and describe drugs and other agents which can be used in conjunction with radiotherapy - e.g. sensitizing agents, protective agents, the effects of oxygen, etc.

l. The student should list and explain basic radio-biological terms e.g. mitosis, metabolite,

 DNA, synthesis, etc.

2. The Cell Cycle.

Describe effects of radiation and chemotherapeutic agents on the normal cell, abnormal cell and inflammatory processes.

Radiosensitivity of normal cells and tumour cells.

Radiobiological effectiveness of different radiations.

3. General effects of radiation on the body, early, late, somatic and genetic.

4. General effects of chemotherapeutic agents on the body - early, late, somatic and genetic.

5. Know the principles of sensitizing and protective agents and describe their mode of action.

(Further, the student would be expected to demonstrate a detailed knowledge of this section and be able to discuss the relevance and importance of radiobiological concepts.

He/she should have knowledge of current regimes using chemotherapy, sensitizing agents and protective agents. )

Principles Affecting the treatment of Benign Conditions

Relief of symptoms, restoration of normal function, etc.

Treatment of malignant disease

The student should be able to outline the role of surgery, radiotherapy, hormone therapy, chemotherapy and other recognized methods of treatment.

The candidate should be able to discuss the design, progress and evaluation of clinical trials.

Treatment modalities

The student should describe the treatment modalities available, and describe in detail acceptable radiotherapy techniques.

Chemotherapy; Hormone Therapy; Radiotherapy; Surgery - the relative value of each modality for individual tumours or tumour sites.

Factors affecting choice of treatment

The student should identify the factors which contribute to the practice of good radiotherapy techniques.

l. Anatomical: accessibility, nature of tumour bed, relationship to other tissues.

2. Biological: type and extent of tumour, tumour sensitivity, age and general condition

 of patient to include current disease, previous treatment

3. Physical: type and source of radiation (alpha, beta and gamma rays, electrons,

 neutrons and X-rays of varying qualities) and other sources of radiation of

 established use. Relative Biological Efficiency of the radiation used, Linear Energy

 Transfer.

The student must be able to evaluate the factors which contribute to the practice of good

radiotherapy techniques. He/she should be able to demonstrate methods of overcoming problems imposed by anatomical, biological and physical limitations.

Choice of Radiation

Students should identify the factors affecting the choice of radiation.

Tumour sensitivity, relation to other structures, selection of equipment.

The student must be able to discuss in detail reasons for the choice of radiation and selection of equipment.

Method of radiation treatment

The student should give a qualitative description of methods of radiation treatment.

Interstitial, intracavitary, brachytherapy, teletherapy, unsealed radionuclides.

The student must have up-to-date knowledge of methods of radiation treatment.

Factors affecting Tumour Dose

The student should describe the factors affecting tumour dose and relate these factors to the treatment of the patient.

Radiosensitivity, therapeutic ratio, radiobiological effectiveness of radiation used, quality of radiation, filtration, treatment volume, focal spot or source skin/ tumour distance, dose rate, fractionation, total dosage.

In addition to the above requirements the student should be able to discuss the factors affecting tumour dose and have a detailed knowledge of them.

Radiotherapy Technique

Number of teaching hours including tutorials and demonstrations = 100

CONTENTS

Aims and Objectives

Application of Radiotherapy Techniques in the Treatment of Benign and Malignant Disease

 Anatomical Systems, Malignant Disease in Children

Localization of Tumours ,Treatment Planning

External Beam Therapy

Mould Room Techniques , Intracavitary and Interstitial Treatments

Use of Unsealed Radionuclides in Common Use

Care of Patient

Care and Use of Accessory Equipment

Protection, Organization and Administration

AIMS AND OBJECTIVES

The aim of the syllabus is to ensure that the student:

1. has the required knowledge and understanding of therapeutic radiography to be able to:

1. Use the equipment accurately and safely in the clinical situation.
2. Administer the treatment with complete accuracy.
3. Understand the responsibility for total patient care, before during and after treatment.
4. Become competent members of the radiotherapy team.

Throughout training, the student must be familiar with the instructions, advice and care required by the patient while attending for treatment.

2. will be able to demonstrate his/her knowledge orally and in writing, and must complete the required record of practical experience.

3 will be able to demonstrate knowledge of a wide range of radiotherapeutic techniques and procedures.

4. To be well read in the current literature relating to radiotherapy technique and oncology In Order to be able to discuss intelligently recently developed techniques and current trends.

5 To be able to demonstrate knowledge and understanding of modern management techniques as applied in the radiotherapy department

6 To be able to discuss the use and control of resources w1th1n the department including technical, manpower and financial resources.

7. To be able to evaluate equipment, to be familiar with technical development and the optimum use of scarce technical resources.

8. To be able to describe ways in which patient care and radiotherapeutic techniques can be taught to Staff and Students and how new techniques be introduced.

9. To be able to describe ways of assessing and maintaining Standards of performance of radiotherapy techniques.

Application of Radiotherapy Techniques in the treatment of Benign and Malignant Disease

The main emphasis is given to the principles of Radiotherapy Technique, with one application of these principles taught in depth for sites where tumours may be found.

The student should have knowledge of other well established techniques, even though these are not seen in the practical training situation.

The student must be able to demonstrate his/her ability to:

l. Interpret the treatment Prescription.

2 Administer the prescribed treatment to patients, appreciating their needs.

*(Further the student should be able to demonstrate detailed knowledge of well established techniques, and be able to discuss a range of techniques and have knowledge of associated problems.)*

ANATOMICAL SYSTEMS

Malignant diseases Should be Considered under the following systems:

Alimentary

Endocrine

Haemopoetic and Reticuloendothelial

Locomotor

Nervous

Reproductive

Respiratory

Sensory organs

Skin

Urinary

MALIGNANT DISEASE IN CHILDREN

Understand special problems, to include after-effects of treatment - e.g. muscle wasting, abnormal development of bone.

Localization of Tumours

The student should be able to describe methods of location and localization in current use.

Methods of location and localization – e.g. clinical radiographic investigation including routine radiography, specialized radiography (including the selection and use of contrast agents), ultrasound, radionuclide investigations and other organ imaging techniques.

TREATMENT PLANNING

The student should have a detailed knowledge of planning techniques and be able to produce manually simple, routine isodose distributions, recognize and interpret dose distributions.

The use of treatment simulation and verification of treatment plan with particular reference to beam-patient-film alignment.

Characteristic isodose distributions of fixed beam and moving beam therapy.

Calculation of dose within the treated volume to include tumour, skin/subdermal doses.

Interpretation and application of treatment prescriptions.

Treatment records relevant to planning.

Use of computers:

Evaluation of the practical applications of computer planning techniques.

External Beam Therapy

The student by working under supervision, must demonstrate his/her practical ability in:

l. Techniques involving the use of single, multiple and regional fields;

2. The use of quality and wedge filters, diaphragms, applicators, compensators and field shaping devices.

The student should have knowledge of techniques involving:

A. Moving beam therapy C. Electron beam therapy

B. Beta ray therapy D. Neutron beam therapy

The use of beam direction devices.

Methods of patient immobilization.

In addition to the above basic requirements the student may have knowledge of :

moving beam therapy

beta ray therapy

electron beam therapy

neutron beam therapy.

and other recently developed methods.

Mould room techniques

The student should be able to list and describe the properties of materials in common use and assist in:

I. The construction of casts, jigs, and beam direction devices.

2. The construction of moulds and applicators for small sealed sources.

3. The construction of protective devices.

In addition the student must : Have the knowledge of evaluation of materials and methods of use.

 Demonstrate knowledge of recent developments.

INTRACAVITARY AND INTERSTITIAL TREATMENTS

The student should be able to:

l. Describe methods in use to include after-loading techniques.

2. Compare the advantages and disadvantages of the various radionuclides available.

3. Explain the significance of dose, fractionation and overall treatment time.

4. Carry out the procedures for cleaning, sterilizing and care of small sealed radionuclides.

5. Discuss and evaluate the various treatment modalities available.

\_ 6. Demonstrate knowledge of recent developments.

7. Demonstrate ability to undertake training and instruction of staff in safe handling of small sealed radionuclides

Use of Unsealed Radionuclides in Common Use

The student should be able to:

1. Their biological action on tissues.

2. Identify the factors used in selecting radiopharmaceuticals.

3. Understand the preparation of radiopharmaceuticals and measurement gf their aetiviq/\_

4. Describe the methods of administration to patients.

5. Understand the problems of nursing and after care of patients receiving treatment with radiopharmaceuticals.

6. The student should have a detailed knowledge of precautions and emergency procedures and have Seen these in a practical training situation.

7. demonstrate Knowledge of legislation in the storage and use of radionuclides,

8. Train of staff and give instruction in safe handling.

Care of Patient

The student must be able to demonstrate his/her ability to care for the patient’s needs and give advice and instruction, before, during and alter treatment.

He or she should be aware of the problems associated with intercurrent disease - e.g. diabetes, tuberculosis and the problems of disabilities such as tracheostomy.

He or she should observe and report any change in the signs and symptoms of patients receiving treatment.

A. General Welfare of Patients.

The care of local reactions including those of skin, mucosa and individual organs.

Diet and fluid intake.

The student must be able to prepare trolleys or trays for clinical procedures in use in a radiotherapy department - e.g. indirect laryngoscopy, taking sputum specimens, changing a trachoestomy tube, etc.

B. Additional care of patients with specific needs

**E.g Children.**

**Irrational patients.**

**Paraplegic patients**.

Anaethetised patients.

Patients with advanced malignant disease.

Patients in the terminal stages of malignant disease.

The student must be able to understand:

(a) The use of blood counts in the control of certain treatments.

(b) The necessity for accuracy in each individual treatment.

(c) The keeping of records and their significance.

Care and Use of Accessory Equipment

The student should observe and know how to:

1. Check all apparatus including dosimetry devices for correct functioning.

2. Recognize, report and record faults.

3. Use and take care of accessory equipment including applicators and secondary diaphragms, filters, beam direction and immobilization devices.

Additionally, Be able to discuss design, maintenance, use and evaluation of accessory equipment.

Protection

***(This section must be emphasized throughout the whole course of training.)***

The student must know the application in the clinical situation of the recommendations contained in relevant statutory and advisory documents, particularly the “Code of Practice for the Protection of Persons against ionizing radiation arising from Medical and Dental Use”.

Know the standard techniques which incorporate the regulations.

Know the special procedures and local rules to be followed in emergency situations when using external beam therapy, sealed and unsealed radionuclides.

Further to this the students should have the knowledge of:

The formulation of local rules for radiation protection.

Monitoring of staff and the working environment.

Responsibilities of the Radiation Safety Officer.

Planning and maintaining radiation protection measures within the department.

Knowledge of relevant statutory and advisory documents.

ORGANISATION AND ADMINISTRATION

Knowledge of relevant legislation and procedures relating to industrial relations.

e.g. Protection of Employment Act; Health & Safety at Work Act;

Sex Discrimination Act; Disciplinary and Grievance Procedures.

Demonstrate knowledge of organization of work flow within the department.

Staffing requirements and recommendations.

Understanding the role of the radiographer in the radiotherapeutic team and the importance of team work and liaison with other groups of staff.

Suggested Reference Books

Physics

First year Physics for Radiographers – Hay G A and Hughes D ( Bailliere Tindil)

Fundamental Physics of radiology – Meedith W J and Massey J B ( John Wright nd Sons Ltd)

X-ray Equipment for Student radiographers - Chesney D N and Chesney M O (Blackwell Scientific Publications)

Essential Physics for Radiographers – Ball and Moore (Blackwell Scientific)

Radioisotopes in Radiodiagnosis – Bligh, Leach and Rhys Davies( Butterworth)

The Code of Practice for the Protection of Persons Against Ionizing Radiations Aising from Medical and Dental Use – (HSMO)

Care of the Patient and Hospital Practice

Care of the Patient in diagnostic Radiography - Chesney D N Chesney M O (Blackwell Scientific)

Practical Nursing. (Nursing Aid Series). - Margaret Clarke (Bailliere Tindall)

‘First Aid’- British Red Cross Society or St Johns Manual

‘Medical Terminology for Radiographers - Davies P (Heinemann)

 ‘Psychology for Nurses’. (Nurses Aid Series) - Altschul (Bailliere Tindall)

 ‘Human Behaviour in lllness’- Lynn Gillis (Faber and Faber)

 ‘The Care of the Cancer Patient’ - Capra (Heinemann)

 ‘Patient Care and Special Procedures in X-ray Technology - Vennes and Watson (Mosby)

Basic Medical Techniques and Patient Care in Imaging Technology – Liliian S Torres et all (Lippincott)

Anatomy, Physiology & Pathology

The general level of this examination is already established. Teachers and students will find value in a range of book on these subjects:

(i) those written specifically for radiographers;

(ii) some written mainly for student nurses;

(iii) books with an emphasis on clinical aspects, written for medical students;

(iv) anatomical atlases;

(V) books on radiographic anatomy;

(vi) books describing surface anatomy; W

(vii) for reference, and to give greater depth on selected topics: major anatomy textbooks, such as

 Gray, and standard texts on human physiology

These include:

‘Basic Anatomy and Physiology for Radiographers . - Dean (Blackwell)

An Atlas of Radiological Anatomy - Weir and Abrahams (Pitman Medical)

 Medical Terminology in Hospital Practice- Davies (Heinemann)

Surface Anatomy for Radiographers - McKears and Owen (Wright)

 Foundations of Anatomy and Physiology- Ross and Wilson (Churchill Livingstone)

Pathology of Tumours - Willis (Butterworth & Co)

 ‘Clinical Anatomy’- Ellis (Blackwell)

Lecture Notes on Pathology’\_ Thomson and Cotton (Blackwell Scientific)

 The Jones Hopkins Atlas of Human Functional Anatomy’- Schlossberg and Zuidema (Bailliere Tindall)

‘Radiographic Anatomy of the Human Skeleton’- Bryan G (Livingstone)

Equipment for Diagnostic Radiography

X-ray Equipment for Student Radiographers - Chesney D N and Chesney M O (Blackwell Scientific)

 Principles of Diagnostic X-ray Apparatusi - Hill (Editor) (Philips Technical Library)

 Fundamental Physics for Radiology - Meredith and Massey (Wright)

 Medical X-ray Techniques in Diagnostic Radiology - Van der Plaats (Macmillan)

Useful information will also be found in equipment manufacturer’s data sheets (it is important that radiographers should understand the characteristics of the equipment which is being marketed).

Radiographic Photography & Imaging Processes (Radiographic Imaging)

For the guidance of teachers, the level to which this subject should be taught is clearly indicated in Radiographic Photography by Chesney and Chesney (Blackwell Scientific Publications), and by Kodak ‘Fundamentals of Radiographic Photography (Kodak Ltd) Recourse will have to be made to a

number of text books for certain aspects of the subject, and teaching staff will have to be aware of current material published in Radiography and ‘The British Journal of Radiology’. The books are listed under two headings those which might be regularly used by students and those to which periodic reference should be made by both students and teaching staff.

**For Regular Use**

‘Radiographic Photography’- Chesney D N and Chesney M O (Blackwell Scientific)

Chesneys’ Radiographic Imaging –sixth edition – John Ball & Tony Price (Blackwell)

 ‘Fundamentals of Radiographic Photography’. (Kodak Ltd)

**For Reference**

Fundamental Physics of Radiology- Meredith and Massey (Wright)

 The Photographic Action of Ionizing Radiations - Herz R H (Wiley-Interscience)

 The Physical Principles of Diagnostic Radiology - Sprawls (University Park Press) - MTP British Agents.

 Radiographic Processing - John D H O (Focal Press)

 ‘Radiographic Photography and Imaging Processes’- Jenkins D J (Churchill Livingstone)

 An Introduction to the Physics of Diagnostic Radiology - Christensen, Curry and Dowdy (Lea and Febiger)

 The Science of Photography - Baines H (Halstead Press)

‘The Focal Encyclopaedia of Photography -(Focal Press)

Radiographic Technique

In learning this particular subject, it is unwise for any student or radiographer to confine his/her studies to a fixed group of books.

The levels of the examinations have been established but learning beyond the appropriate level will further enhance the radiographer’s ability.

It is suggested that studies might cover the following six sources:

(i) Books which cover the whole range of diagnostic radiographic procedures.

(ii) Books which are devoted to a specialized branch of radiography.

(iii) Textbooks of radiology - particularly those which deal with practical procedures, rather than

 with diagnosis.

(iv) Textbooks which describe the principles and practice of diagnostic techniques allied to

 radiology.

(v) Books and technical leaflets, including those produced by commercial companies, which

 describe particular radiological contrast agents and their uses.

(vi) Journals and periodicals concerning radiography and radiology.

**Suitable books include:**

‘Diagnostic Radiography’ - Glenda J Bryan (Churchill Livingstone)

A Guide to Dental Radiography; Dental Practitioners’ Handbook No 27 - Mason (John Wright & Sons)

Clark’s ‘Positioning in Radiography - Kreel (Editor) (Heinemann)

Merrill’s atlas of Radiographic Positioning & Procedures – Eugine D Frank et all (Mosby)

A guide to radiological procedures - Chapmen

A Textbook of Medical Ultrasound

 A Textbook of Nuclear Medicine

‘Paediatric Radiography’- Gyll (Blackwell Scientific)

‘Practical Procedures in Diagnostic Radiography - Saxton and Strickland (H K Lewis)

‘Special Techniques in Orthopaedic Radiography’ - Stripp W (Churchill Livingstone)

**Suitable journals include:**

‘Radiography’

British Journal of Radiology’

 ‘Clinical Radiology’

Students will need to revise from the recommendations and, in addition, should complement their study by reference to textbooks on Radiology.

eg ‘Textbook of Radiology and Imaging’ Ed. Sutton (Longman)

They should also read the various trade journals

eg ‘Medical Radiography and Photography’ - Kodak

‘Electro Medica’ - Siemens

‘Medicamundi’ - Philips Electrical

If possible studnts should read comparable journals of other countries.

**Radiotherapy Physics & equipment**

Fundamental Physics of Radiology - W J Meredith and J B Massey (Wright & Sons Bristol)

A Concise Textbook of Rad1otherapy - P Barnes and D J Rees (Faber)

 ‘A Short Textbook of Radiotherapy - J Walter, H Miller and C K Bomford (Churchill Livingstone)

Relevant ‘Codes of Practice’.

***Further reading***

Physics of Radiology - H E Johns (Charles C Thomas)

**Radiotherapy & Oncology**

‘A short Textbook of Radiotherapy’. 4th Edition. - Walters, Miller and Bomford (Churchill Livingstone)

 ‘Fundamentals of Radiation Therapy’ - Lowry (English University Press)

 ‘Biological Effects of Radiation’ - Coggle (Wykeham)

 ‘A Concise Textbook of Radiotherapy - Barnes and Rees (Faber)

 ‘Principles of Radiation Therapy’ - Deeley (Butterworth)

 ‘Care of the Cancer Patient’ - Capra (Heinemann)

 ‘Radiotherapy in Modern Clinical Practice’- Hope and Stone (Crosby Lockwood and Staples)

 ‘Cancer in Children’. - Bloom UICC (Springer Verlag)

 ‘Clinical Oncology’. UICC (Springer Verlag)

 ‘TNM Classification of Malignant Tumours’ - UICC (Springer Verlag)

Further Reading

‘A Concise Textbook of Radiotherapy. – Barnes and Rees (Faber and Faber)

Pathology - Mayers (Unibooks)

 ‘An Introduction to the General Pathology of Tumours’ - Ashley (Wright)

‘Fundamentals of Radiation Therapy’- Sidney Lowry (English University Press)

‘Clinical Oncology - UICC S (Springer-Verlag)

 ‘Biological Effects of Radiation’. Cogg1e (Wykeham)

‘Oncology for Nurses and Health Care Professionals’.

Vol 1 Pathology, Diagnosis and Treatment

Vo] 2 Caro and Support ‘Biological Defence Mechanisms’

Tiffany (Editor) (Mosby)

 ‘A Short Textbook of Radiotherapy’ - Walter, Miller and Bomford (Churchill Livingstone)

‘TNM Classification of Tumours - UICC (Springer verlag)

 ‘Textbook of Radiotherapy - 2nd Ed – 1973 - G H F1etCher`(Lee and Febiger)

‘Introduction to Radiation Protection’. - Markin and Harbison (Science paperback)