

# **MADHYA PRADESH PARAMEDICAL COUNCIL**

## **BACHELOR OF X-RAY RADIOGRAPHER TECHNOLOGY (B.X.R.T.)**

### **(A THREE-YEARS DEGREE PROGRAMME )**

#### **SYLLABUS :**

##### **FIRST YEAR**

Paper I. Anatomy and Physiology of Human Body – Part -I

Paper II. Radiographic Photography

Paper III. Basic Radiological Physics

Paper IV. Radiation protection & Radiation Prology

##### **SECOND YEAR**

Paper I. Anatomy and Physiology of Human Body – Part -II

Paper II. Radiation Physics including Radiation Protection

Paper III. Basic Radiographic Techniques

Paper IV. C.T. imaging techniques & M.R.I. imaging techniques .

##### **THIRD YEAR**

Paper I. Radiotherapy Planning & Quality Control.

Paper II. Equipment for Radiodiagnosis including newer development and quality control of C.T.M.R.I. imaging us digital radiography.

Paper III. Special Radiographic techniques including special procedures & investigation in Radiography such as - Angiography, I.V.P Barium – meal studies, Cholungiography Silography, Bronchography etc.

Paper IV. Digital Radiography Basic principles and compounded Radiography and internal working procedure C.D. Priminary of images.

# FIRST YEAR

## PAPER I

### Anatomy and Physiology of Human Body:

#### 1. Introduction to the body as a whole.

**The cells:** tissues of the body.

**The cell:** Structure, multiplication.

**Tissues:** types, structure, characteristics, functions.

**Epithelium: Simple:** Squamous, Cuboidal, Columnar, Ciliated

**Compound:** Stratified, transitional

**Connective:** Areolar, adipose, fibrous, elastic, cartilage, blood and bone.

**Muscles:** Striated (Voluntary), smooth (involuntary), Cardiac

**Nervous**

**Fibrosis**

**Cell regeneration**

**Membranes:** mucous, serous, synovial

System Wise Osteology (including whole skeleton, bones and joints) Development of bone (osteogenesis): cells involved Types and function of bone, Types of joints and various movement.

**Axial Skeleton:**

**Skull:** cranium, face, ear, and sinuses.

**Vertebral Column:** regions, movement and vertebrae characteristics sternum Ribs

**Appendicular skeleton:** bones involved – shoulder girdle and upper limb. Pelvic girdle and lower limb.

**Healing of bones:** cellular activity factors that delay healing. Diseases of bones and joints.

## **PAPER II**

### **Radiographic Photography**

**(i) The photographic process:** introduction, visible light, image, produced by radiation, light sensitive photographic materials.

**(ii) Photographic emulsions:** The photographic latent image. Positive process.

**(iii)** Film materials in x-ray department. History, structure of an x-ray film, single sided films, types of films.

**(iv)** Spectral sensitivity of film material, graininess of film material, speed and contrast of photographic material.

**(v) Sensitometry:** photographic density, characteristic curve features of the characteristic curve.

**(vi)** Variation in the Characteristic curve with the development. Comparison of emulsions by their characteristic curves. Information from the characteristic curve.

**(vii) The storage of film materials and radiograph:** Storage of unprocessed films, storing of radiographs.

**(viii) Intensifying screens and cassettes. Luminescence:** fluorescence and phosphorescence. Construction of an intensifying screen.

**(ix)** The fluorescent materials. Types of intensifying screens. Intensification factor. The influence of KV, scattered radiation. Detail, sharpness and speed, size of the crystals, reciprocity failure.

**(x)** Cassette design, care of cassettes, mounting of intensifying screens.

**(xi)** Care of intensifying screens, tests to check screen film contact and light leakage.

**(xii) Film processing:** Development: The nature of development, manual, automatic. The PH scale.

**(xiii)** The constitution of developing solutions and properties of development chemicals.

**(xiv)** The development time, factors in the use of a developer. Developers in processing systems.

**(xv) Film processing:** fixing and role of a fixing solution. Constitution of the fixing solutions and properties of the Constituents.

**(xvi)** Fixers used in automatic processors. Factors affecting the use of the fixer.

**(xvii)** Regeneration of fixing solution. Silver recovery and its various methods.

**(xviii)** Rinsing, washing and drying. Objects of rinsing and washing, methods employed. Methods of drying films.

**(xix)** Preparation of solutions and making stock solution.

**(xx) Processing equipment:** Materials for processing equipment, processors for manual operation, hangers, and control of chemical temperature by heating and thermostat, immersion heaters as well as cooling methods.

**(xxi)** Maintenance of automatic processors and common faults.

**(xxii) Dark room:** Layout and planning. Dark room construction nature of floor, walls, ceiling and radiation protection.

**(xxiii)** Type of entry door design. Dark room illumination.

**(xxiv)** Dark room equipment and its layout. Location of pass through boxes or cassettes hatches.

**(xxv) Systems for daylight film handling:** Daylight systems using cassettes and without cassettes.

**(xxvi) The radiographic image:** Components in image quality- density, contrast and details.

**(xxvii)** Unsharpness in the radiographic image. Various factors contributing towards unsharpness.

**(xxviii)** The presentation of the Radiograph. Identification markers and orientation. Documentary preparation.

**(xxix) Viewing accessories:** Viewing boxes, magnifiers, viewing conditions.

**(xxx)** Light images and their recording. The formation of light images. Images formation by mirror, by a lens and aberrations of lenses.

**(xxxi) Fluorography:** An optical system for image intensifier fluorography.

**(xxxii)** Cameras for fluorography. Sensitometric response of fluorography film.

**(xxxiii)** Processing equipment and procedures, graininess in fluorograms.

**(xxxiv)** Some special imaging processes. Xero radiography, its meaning technique and applications.

**(xxxv)** Copying radiograph. Its technique and application.

**(xxxvi) Subtraction:** Its techniques as applied to radiography as well as its applications.

**(xxxvii)** Common film faults due to manufacturing as well as due to chemical processing.

**(xxxviii)** Management of the quality of the Radiographic image.

**Practicals:**

- A. Test to check the X-ray films and screen contact in the cassette.
- B. Test to check light leakage in the cassette.
- C. To prepare a characteristic curve of a radiographic film.
- D. To check the effect of safe light on exposed as well as unexposed X-ray film.

## **PAPER III**

### **BASIC RADIOLOGICAL PHYSICS**

Structure of matter and principles of machines, electricity and electromagnetism applied in radiological instruments. Physics principles in design and working of x-ray tube technology. Construction and working principles of transformers and autotransformers used in x-ray circuits. Measurement of voltage special KV meters. Measurement of tube current in milli and microamperes. Principles of thermionic emission and rectification in x-ray technology. High voltage D.C. circuits in imaging and therapy tube circuits. Electrical hazards and safety x-ray tube rating in imaging and therapy x-ray tubes and thermal safety. Introduction to intensity of radiation in general and its variation by distance. Introduction to eletroma-genetic spectrum, definition of wavelength and its quantum relationship with peak kilovoltage. Physical principles of radiation and optical field coverage and the factor affecting the field projected on patient during x-ray imaging and radiotherapy exponential and trigonometric functions used in radiological calculations.

## **PAPER IV**

### **Radiation Protection and Radiation Prology**

Definition of radiation hazards maximum permissible dose and annual limit of intake (ALI), permissible dose levels on and around sealed source housing and installation principles of radiation protection and MPD's of different ICRP rules, stochastic and non-stochastic effects. Importance of 'ALARA' physical principles of design and planning of radiation installation. Safe work practice in tele therapy and Brach therapy. Shielding materials, radiation surveys and personnel monitoring devices film badges. TLD badges, pocket dosimeters.

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# **SECOND YEAR**

## **PAPER I**

### **Anatomy and Physiology of Human Body :**

Types of cells, tissues, bones and joints. Introduction to system and cavities of the body.

**(1) The respiratory system: Organs:** Positions and structure nose and nasal cavities

**Functions:** respiratory, olfactory,

**Pharynx Larynx – Functions:** respiratory, vocal Teaches, Bronchi,

**lungs:** lobes, lobules, pleura.

**Respiratory function:** External and internal respiration common terms relating to diseases and conditions of the system.

- (2)** Cardionescular System
- (3)** Alimentary System
- (4)** Excretory System
- (5)** Reproductione System
- (6)** Nervous System
- (7)** Lymphatic System
- (8)** Haemopoite System
- (9)** Special sense Organs

**Heart and Blood vessels** (Circulatory system) Blood vessels: arteries, veins, capillaries, sinusoids, structure and functions. Heart: Position, structure and functions. Circulation of Blood: Pulmonary, systemic, portal, main blood vessels, their origins and distribution, diseases of blood vessels and Heart and conditions of the system.

### **The Lymphatic System :**

The parts of the lymphatic system.

**Lymph channels :** Capillaries. Vessels, ducts, structure and functions. Lymph nodes: Position, structure and functions.

**Lymphatic tissues :** Tonsils, adenoids, and intestinal nodules.



**Spleen** : Position, structure and functions, diseases and conditions of the system.

### **The Digestive System :**

**Elementary tract structure:** Mouth, pharynx, salivary glands, oesophagus, stomach, liver, gall bladder,

Small intestine, large intestine: Position, structure and functions of these organs. Digestion and Absorption, metabolism of carbohydrates, proteins and fats. Diseases and conditions of the system.

**The Urinary System** : Parts of urinary system. Position, structure and functions. Kidneys, ureters, urinary bladder and urethra. Formation and composition of urine. Water and electrolyte balance. Diseases and conditions of the system. The Reproductive System:Female Reproductive system:

**External genitalia** : Position, structure and functions. Perineum. Internal organs: Position and structures, Vagina, uterus tubes, ovaries. Menstrual cycle: Stages, hormone control, and ovulation. Breasts (Mammary glands). Changes: Puberty in pregnancy, during lactation.

### **Male Reproductive System :**

Scrotum, testis, and epididymus: Position, structure and functions. Spermatogenesis.

Spermatic cords, seminal vesicles.

Ejaculatory ducts: Position, structure and functions.

Prostate gland Functions of male reproductive system,

Puberty.Diseases of female and male reproductive system.

### **The Endocrine System :**

Endocrine glands, Pituitary and hypothalamus: Position and structure. Thyroid gland, Parathyroid glands. Adrenal (Supra renal) glands. Pancreas: Position, types of cells. Hormones: secretion, function & control, pineal gland. Common terms and diseases related to the system.

### **The Organs of Sense:**

Hearing and the ear:

External, middle and inner ear.

Physiology of hearing & diseases of ear

Sight and the eye: Position, structure, sclera, cornea, choroids, ciliary body, iris, lens, retina, and optic nerves. Physiology of sight and diseases of the eye.

Sense of smell : Olfactory nerves, origins, distribution. Physiology of smell. Sense of taste.

### **The Nervous system:**

Neurones: Structure, types and properties.

Central nervous system: nerves, neurologia meninges.

Ventricles of brain, C.S.F.

Brain, spinal cord: Structure, functions peripheral nervous system.

Spinal and cranial nerves: Origin distribution & functions. Automatic nervous system: Sympathetic and Para Sympathetic: Origin distribution functions.

Common diseases of the system.

### **The Skin :**

Structure of skin, epidermis, dermis, functions of skin, hypothermia.

Wound healing: Primary and secondary diseases of skin.

## **PAPER II**

### **RADIATION PHYSICS INCLUDING RADIATION PROTECTION**

Atomic structure as applied to generation of x-rays and radioactivity spectrum of diagnostic imaging and therapy x-rays. Effects of variation of tube voltage, current, filtration, HT waveform and target material on x-ray production. Laws of radioactivity and decay schemes of different alpha, beta, gamma ray, negatron and positron emitters as used in medicine especially in radiotherapy. Artificial radionuclide generators employed in medicine in general and radiotherapy sources in particular. Interaction of radiation with matter attenuation absorption and scattering phenomena. Photoelectric absorption, Compton scattering, pair production and annihilation process, ionisation, effects of geometry of thickness of the absorber. Dependence on the nature and atomic number of the absorber and on radiation quality. Transmission of x-ray through body tissues. Linear energy transfer. Range of secondary electrons and electron build up. Relative amounts of scatter from homogeneous and heterogeneous beam during the passage through a patient. Physical requirements of beam defining devices e.g. cones, diaphragm, collimators etc. Units of radiation measurement specification of quality and half-value thickness (HVT) and its measurements, filters and filtration. Measurements of radiation and dosimetric procedures. Radiation detectors and their principles of working. Definitions of Bragg-peak, percentage depth dose, and peak scatter factor, tissue air-ratio, tissue maximum ratios scatter air ratio, isodose curves and radiation penumbra of different beams. Wedge filters, scattering foils. Physics properties of phantoms, phantom materials, bonus and bolus substitutes. Factors used for treatment dose calculation method. Physical aspects of electron and neutron beam therapy.

## **PAPER III**

### **BASIC RADIOGRAPHIC TECHNIQUES**

**Skeletal system:** Radiography techniques for x-ray of:

(a) Upper limb with special reference to hand, wrist joint, and elbow joint, supplementary techniques for carpal tunnel, scaphoid bone fracture, head of radius and supra-condylar projections.

(b) Lower limb which includes all the bones with special reference to ankle joint, knee joint, patella, techniques for calcaneum bone, supplementary techniques for flat, intercondylar notch and femur and metatarsals, etc.

(c) Shoulder girdle and thorax.

(d) Vertebral column with special techniques for cervical spine, intervertebral joints and foramina. Lumbo-sacral joint.

(e) Pelvic girdle and hip region.

(f) Respiratory system chest radiography for both the lungs, apical, lordotic and oblique views, techniques to decubitus AP and lateral views.

**Skull:** Radiography of cranial bones, cranium, sella turcica, orbit, optic foramina, superior orbital fissure and inferior orbital fissure.

**Facial Bones:** Para nasal sinuses. Temporal bone.

**Dental Radiography:** Radiography of teeth-intra oral, extra oral and occlusal view.

**Alimentary Tract:** Preparation of patients, contrast media for swallow, meal and enema.

**Abdomen:** Preparation of patient. General, acute positioning for fluid and air levels. Plain film examination. Radiography of female abdomen to look for pregnancy: Intravenous Pyelography and cystography.

**Macro radiography:** Principle, advantage, technique and applications.

**Stereography:** Procedure- presentation for viewing, stereoscopes, stereometry.

## **PAPER IV**

### **C.T. IMAGING TECHNIQUES & MRI IMAGING TECHNIQUES**

Basic Physics of CT & MRI, Basic Computer Operation, Positioning in CT & MRI. Different types of Contrast materials. Radiation Hazards and MRI Hazards. Factor affecting quality of images.

Basic data acquisition concepts, reformation and reconstruction of CT images and image archieving.

CT planning of Head, Neck, Thorax, Abdomen, Pelvis. Musculoskeletal System, Spine and PNS, Patient preparation and handling.

Historical background, various generation of scanner, advancements in CT Technology (helical multislice and spiral) ultrafast scanners, CT guided interventions procedure and CT Angiography.

Emergencies in C.T. Departments – contrast media and its reactions, anaphylaxis.

MRI – History, advantage over other modalities, equipment terminology NMR signals, pulse sequences, site selection and safety, strength and limitations of MRI.

MRI of Head & Neck, Thorax, Abdomen. Musculoskeletal system.

## **THIRD YEAR**

### **PAPER I**

#### **Radiotherapy Planning and quality control**

**Demonstration** : Definition of treatment planning. Planning procedure in general with special emphasis on tumour localization and target volume measurement by conventional radiographic method and simulator imaging. Role of special contrast medium base radiotherapy, CT/ MRI/ Ultrasound/ radionuclide imaging methods. Physical and clinical requirement of field selection of treatment in teletherapy. Role of portal films in treatment planning. Choice of central axis percentage depth dose data and isodose curves from a spectrum of radiotherapy beams used for treatment. Requirement and practice of organ shielding single, multiple fields pendulum and rotational field therapy planning procedure. Computerized treatment planning system choice of dose, time and fractionation. Safety of critical organ in planning methods. Role of treatment immobilization devices and laser in patients set up and positioning.

Acceptance tests on therapy simulators, teleisotope, megavoltage X-ray and electron beam machines. Contribution of technologist in radiation calibration, quality control, assurance in execution of radiation treatment,

## **PAPER II**

### **Equipment for Radio-diagnosis including newer Development and quality control**

**Demonstration** : Computed tomography: Historic developments, its principle and applications, various generations and applications, various generations and definition of term and cross sectional anatomy.

Diagnostic Ultrasound: Its principle, applications and role in medicine. Various types of transducers and definition of terms and cross sectional anatomy.

Digital radiography: Principle scanned projection radiography, digital subtraction angiography, applications and definition of terms.

M.R.I Principle, applications, its advantage over computed tomography or ultrasonography. Its limitations and uses and cross sectional anatomy.

Quality Assurance in Radio diagnosis: Aim of quality assurance in medical care Contents of a Q.A. Programme i.e. phases of development of a radiological facility. Q.A. activities applicable in.

- i. Equipment section phase.
- ii. Equipments installation of acceptance phase.
- iii. Operational phase

## **PAPER III**

### **Radiography:- Techniques including special procedures.**

Radiological procedure pertaining to salivary glands, lacrimal system, bronchography, arthrography and hystero salpangiography-various requirements trolley set up, indications and contra indications, contrast media used.

**Ventriculography and Encephalography-** Technique, contrast media used, film sequence indication and contra indications.

**Myelography:** Techniques contrast media used injection of contrast media indications and contra indications.

Intra venous Cholangiography, T.Tube: Cholangiography, preoperative/ Cholangiography , procedure. Contrast media, indication & contra indication.

Double contrast Barium studies (small bowel enema, Ba enema etc) procedure, requirement indications contra, indication and contrast media used

**Angiography:** Cerebral , cardiac abdominal aortography general, renal and selective renal splenoportovenography peripheral arterial and venous angiography, precautions radiation protection film changers manual automatic biplane film type- large miniature cine contrast media injection procedure and technique.

Interventional radiological procedures:

PTS PTCP Cine needle aspiration cytology, percutaneous nephrostomy cardiac catheterization - embolization dilations etc.



## **PAPER IV**

### **Digital Radiography**

Digital Radiography Basic principles and compounded Radiography and internal working procedure, C.D. Primary of images.

### **Digital Radiography Systems**

Image acquisition, Photostimulable phosphors, digital chest radiography and future developments

Digital Spot Imaging (DSI)

Picture characteristics, archiving possibilities : transfer system and designs.

### **Mammography System**

Background, diagnosis and screening.

Imaging requirements

Equipment – tube, compression, grids, AEC

Image receptor requirements.

Radiation dose, Image quality

Interventional – accessories

Biopsy equipment attachments.

### **Film archiving systems**

Image recording devices, Laser imager/camera-functioning, Multiformatter, Automatic film handling systems.

Picture archiving and communications system (PACS)

Optical Disc. System (ODS)

Film archiving systems – MOD/disc/PACS etc.