B.Sc RADIOGRAPHY AND IMAGING TECHNOLIGY SYLLABUS FOR III SEMESTER

I Introduction to Healthcare Delivery System in India

1. Introduction to healthcare delivery system a. Healthcare delivery system in India at primary, secondary and tertiary care b. Community participation in healthcare delivery system c. Health system in developed countries. d. Private Sector e. National Health Mission f. National Health Policy g. Issues in Health Care Delivery System in India

2. National Health Programme- Background objectives, action plan, targets, operations, achievements and constraints in various National Heath Programme.

3. Introduction to AYUSH system of medicine a. Introduction to Ayurveda. b. Yoga and Naturopathy c. Unani d. Siddha e. Homeopathy f. Need for integration of various system of medicine

4. Health scenario of India- past, present and future

5. Demography & Vital Statistics Demography – its concept Vital events of life & its impact on demography g. Significance and recording of vital statistics h. Census & its impact on health policy

6. Epidemiology i. Principles of Epidemiology j. Natural History of disease k. Methods of Epidemiological studies l. Epidemiology of communicable & non-communicable diseases, disease transmission, host defense immunizing agents, cold chain, immunization, disease monitoring and surveillance.

II Basics Physics including Radiological Physics

1. Basic concepts: Units and measurements-Force, work, power and energy-Temperature and heat-SI units of above parameters. Atomic structure-atom model-Nucleus-electronic configuration-periodic table-Isotopes-Ionization-excitation-Binding energy-electron voltElectromagnetic radiation-Quantum nature of radiation-mass energy equivalenceFluorescence-electromagnetic spectrum.

2. Electricity and magnetism: Electric charges, Coulomb's law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and Capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law. Varying currents-Growth and decay of current in LR circuit time constant, charge and discharge of a Capacitor through a resistance and inductance. Oscillations in an LC circuit. Alternating currents: Peak and RMS values and current and voltage, circuit containing LR, CR and LCR-Power factor, series and parallel LCR circuits, DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, heating effect of current.

3. Electromagnetic waves: Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atmosphere.

4. Sound. a. The nature and propagation of sound wave (the characteristics of sound, wave theory), speed of sound in a material medium, intensity of sound, the decibel, Interference of sound waves, beats, diffraction. b. Doppler's effect, Ultrasonic wave, production of ultrasonic waves (piezo-electric effect) in ultrasonography. c. Use of principle of Doppler's effect in Diagnostic Radiology (e.g. Echo, blood flow measurement).

5. Heat Definition of heat, temperature, Heat capacity, specific heat capacity, Heat transferconduction, convection, radiation, thermal conductivity, equation for thermal conductivity (k), the value of k of various material of interest in radiology, thermal expansion, Newton's law of cooling, Heat radiation, perfect black body, Stefan law, application in Diagnostic Radiology (Heat dissipation in both stationary and rotating X-ray tubes).

6. Electronics. a. Semiconductors; Conduction in crystals, Energy bands. Intrinsic and Extrinsic semiconductors n-type and p-type semiconductors, majority and minority carriers. b. Semiconductor diodes: p-n junction-properties forward and reverse bias, characteristics of p-n junction Rectifiers-Half-wave and full wave, ripple factor, Efficiency of HW and FW rectifiers. Filter circuits; Zener diode, regulated power supply. c. Transistors-Symbols, Transistor connections and characteristics, Transistor as an amplifier, load line analysis, operating point, types of amplifiers-voltage and power amplifiers. Feedback-negative feedback in amplifiers,

Basic Radiological Physics

a. X-rays: Discovery of x-rays-X-ray production and properties: Bremsstrahlung radiations-Characteristics X-Rays, factors affecting X-ray emission spectra, X-ray quality and quantity, HVL measurements, heel effect, soft and hard X-Rays, added and inherent filtration, reflection and transmission targets.

b. Interaction of ionizing radiation with matter-Types of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation.

c. Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, and linear attenuation coefficientcoherent scattering-photonuclear disintegration-Particle interactions. Interactions of X rays and Gamma rays in the body; fat-soft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance.

d. Exponential attenuation (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number.

e. Radiation intensity and exposure, photon flux and energy flux density.

f. LET, range of energy relationship for alpha, beta particles with X-Rays.

g. X-ray tube: historical aspects, construction of X-ray tubes, requirements for Xray production(Electron source, target and anode material), tube voltage, current, space charge, early X-ray tubes(Coolidge tubes, tube envelop and housing) cathode assembly, X-ray production efficiency, advances in X-ray tubes, anode angulation and rotating tubes-line focus principle-space charge effect, tube cooling-Modern X-ray tubes-stationary anode, rotating anode, grid controlled Xray tubes, heel effect, off focus radiation, tube insert and housing-Tube ratingQuality and intensity of x-rays-factors influencing them.

h. Grid controlled and high speed tubes, focal spot size, speed of anode rotation, target angle, inherent filtration, radiation leakage and scattered radiation).Interlocking and X-ray tube overload protection.

i. Heat dissipation methods, tube rating, heat units, operating conditions and maintenance and Q.A procedures.

j. Filament current and voltage, X-ray circuits (primary circuit, auto transformer), types of exposure switch and timers, principle of automatic exposure control (AEC) and practical operation, filament circuit, high voltage circuits, half wave, full wave rectification, three phase circuits. Types of generators, 3 phase, 6 and 12 pulse circuits-high frequency generators-falling load generators, Capacitors discharge and grid control systems.

k. X-ray generator circuits: Vacuum tube diodes-semi-conductor diodes-transistorRectification-half and full wave-self rectification-X-ray generator; filament circuitkilo Voltage circuit-single phase generator-three phase generator-constant potential generator-Fuses, switches and interlocks-Exposure switching and timers-HT cables-earthing.

l. Physical quantity, its unit and measurement: Fundamental and derived quantity, SI unit, various physical/radiation quantity used in Diagnostic Radiology and its unit (for example, KVp, mA, mAS, Heat unit (HU

III Conventional Radiological Equipment

1. Production of x-rays: X-ray tube, gas filled x-ray tube, construction working and limitations; stationary anode x - ray tube; construction, working, methods of cooling the anode, rating chart and cooling chart; rotating anode x - ray tube: construction, working rating chart, speed of anode rotation, angle of anode inclination, dual focus and practical consideration in choice of focus, anode heel effect, grid controlled x - ray tube; effect of variation of anode voltage and filament temperature; continuous and characteristics spectrum of x - rays, inherent filter and added filter, their effect on quality of the spectrum.

2. High tension circuits: H.T. generator for x-ray machines, three phase rectifier circuits, three phase six rectifier circuit, three phase 12 rectifier circuit, high and medium frequency circuits; capacitance filter control and stabilizing equipment; mains voltage compensator, mains resistance compensator, compensation for frequency variation, control of tube voltage, kV compensator; high tension selector switch, filament circuit, control of tube current, space charge compensation.

3. Meters and exposure timers: Moving coil galvanometer: construction and working/conversion to millimeter, ammeter and voltmeter, meters commonly used in diagnostic x-ray machines, pre reading kV meter and millimeter, digital panel meters. Clockwork timers, synchronous motor timer, electronic timers, photo metric timers (fluorescent and photoelectric effect as applied in timers), ion chamber based timers, integrated timer.

4. Interlocking circuits: Relays: description and working, use of relays in diagnostic machines for over load protection, circuit diagram; simplified circuit and block diagrams illustrating sequence of events from mains supply to controlled emission of x-rays.

5. Control of scattered radiation: Beam limiting devices: cones, diaphragms, light beam collimator, beam centering device, methods to verify beam centering and field alignment; grids; design and control of scattered radiation, grid ratio, grid cut-off, parallel grid, focused grid, crossed grid, grided cassettes, stationary and moving grid potter bucky diaphragms, various types of grid movements; single stroke movement, oscillatory movement and reciprocatory movement.

6. Fluoroscopy: Fluorescence and phosphorescence - description, fluorescent materials used in fluoroscopic screens, construction of fluoroscopic screen and related accessories, tilting table, dark adaptation. Image intensifier - Construction and working, advantages over fluoroscopic device, principles and methods of visualising intensified image, basic principles of closed circuit television camera and picture tube. Vidicon camera, CCD. Automatic brightness control, automatic exposure control, chamber selection during fluoroscopy. Serial radiography: Manual cassette changer, rapid automatic film changer, basic principles of cine fluoroscopy and angiography use of grid controlled x-ray tube.General care; functional tests; testing the performance of exposure timers, assessing the MA settings, testing the available KV, measurement of focal spot of an x-ray tube, testing the light beam diaphragm, practical precautions pertaining to Brakes and locks, H.T. cables, meters and controls, tube stands and tracks as well as accessory equipment

IV Clinical Radiography- Positioning Part 1

1. Skeletal system:

a) Upper limb: Technique for hand, fingers, thumb, wrist joint carpal bones, forearm, elbow joint, radio ulnar joints and humerus supplementary techniques for the above. E.g. Carpal tunnel view, ulnar groove, head of the radius, supracondylar projections.

b) Lower limb: Technique for foot, toes, great toe, tarsal bones, calcaneum, ankle joint, lower leg, knee, patella & femur. Supplementary techniques: Stress view for torn ligaments,

- Subtalar joint and talo calcaneal joint.
- Inter condylar projection of the knee.
- Tibial tubercle.
- Length measurement technique.

c) Shoulder girdle and thorax: Technique for shoulder joint, scapular, clavicle, acromio clavicular joints, sternum, ribs, sterno-clavicular joint. Supplementary projections and techniques

- Recurrent dislocation of shoulder.
- Traumatic dislocation of shoulder.
- Cervical ribs.

d) Vertebral column: Technique for atlanto-occipital joint, cervical spine, cervico thoracic spine, thoracic spine, thoraco- lumber spine, lumbo sacral spine, sacrum and coccyx. Supplementary techniques to demonstrate:

- Scoliosis
- Kyphosis
- Spondylolisthesis
- disc lesion
- Union of spinal graft.

e) Pelvic girdle and hip region: Technique for whole pelvis. Ilium, ischium, pubic bones, sacro iliac joint, symphysis pubis, hip joint, acetabulum neck of femur, greater and lesser trochanter. Supplementary techniques-

• Congenital dislocation of hips

• Epiphysis of femur

• Lateral projections for hip joints to show femoral head and neck relationship.

f) Skeletal survey: Skeletal survey for metabolic bone disease, metastases, hormonal disorder, renal disorders.

g) Skull: Basic projections for cranium, facial bones, nasal bones and mandible. Technique for

• Petrous temporal for mastoids. Internal auditory canal. - Accessory nasal sinuses.

• Tempero - mandibular joint. - Orbits and optic foramen.- Zygomatic arches.

• Styloid process. - Pituitary fossa. - Jugular foramen.

2. Dental Radiography- Technique for intra oral full mouth.- Occlusal projections.- Extra oral projections including orthopantomography.- Supplementary techniques.

3. Upper respiratory system- Technique for post nasal airways, larynx, trachea, thoracic inlet, Valsalva manoeuvre. - Phonation.

4. Lungs and Mediastinum: Technique for routine projections- Supplementary projections: Antero-posterior, obliques, lordotic, apical projection, use of penetrated postero-anterior projection. - Expiration technique. - Technique for pleural fluid levels and adhesions.

5. Abdominal viscera- Technique for plain film examination. - Projection for acute abdomen patients. - Technique to demonstrate: Foreign bodies, Imperforate anus.

6. Radiography using mobile X-ray equipment- Radiography in the ward: Radiography in the specialized unit, such as: Intensive care unit, Coronary care, Neonatal unit.- Radiography in the operating theatre.

Practicals

Radiographic positioning of all parts of the body.

V Professionalism and values

1.Professional values- Integrity, Objectivity, Professional competence and due care, Confidentiality

2. Personal values- ethical or moral values

3. Attitude and behavior- professional behavior, treating people equally

4. Code of conduct , professional accountability and responsibility, misconduct

5. Differences between professions and importance of team efforts

6. Cultural issues in the healthcare environment

B.Sc RADIOGRAPHY AND IMAGING TECHNOLIGY SYLLABUS FOR IV SEMESTER

I Introduction to Quality and patient safety

1. Quality assurance and management - The objective of the course is to help students understand the basic concepts of quality in health Care and develop skills to implement sustainable quality assurance program in the health system. a. Concepts of Quality of Care b. Quality Improvement Approaches c. Standards and Norms d. Quality Improvement Tools e. Introduction to NABH guidelines

2. Basics of emergency care and life support skills - Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include immediate recognition of sudden cardiac arrest (SCA) and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also considered part of BLS. The student is also expected to learn about basic emergency care including first aid and triage. Topics to be covered under the subject are as follows: a. Vital signs and primary assessment b. Basic emergency care – first aid and triage c. Ventilations including use of bag-valve-masks (BVMs) d. Choking, rescue breathing methods e. One- and Two-rescuer CPR f. Using an AED (Automated external defibrillator). g. Managing an emergency including moving a patient At the end of this topic, focus should be to teach the students to perform the maneuvers in simulation lab and to test their skills with focus on airways management and chest compressions. At the end of the foundation course, each student should be able to perform and execute/operate on the above mentioned modalities.

3. Bio medical waste management and environment safety- The aim of this section will be to help prevent harm to workers, property, the environment and the general public. Topics to be covered under the subject are as follows: a. Definition of Biomedical Waste b. Waste minimization c. BMW – Segregation, collection, transportation, treatment and disposal (including color coding) d. Liquid BMW, Radioactive waste, Metals / Chemicals / Drug waste e. BMW Management & methods of disinfection f. Modern technology for handling BMW g. Use of Personal protective equipment (PPE) h. Monitoring & controlling of cross infection (Protective devices)

4. Infection prevention and control - The objective of this section will be to provide a broad understanding of the core subject areas of infection prevention and control and to equip AHPs with the fundamental skills required to reduce the incidence of hospital acquired infections and improve health outcomes. Concepts taught should include – a. Evidence-based infection control principles and practices [such as sterilization, disinfection, effective hand hygiene and use of Personal protective equipment (PPE)], b. Prevention & control of common healthcare associated infections, c. Components of an effective infection control program, and d. Guidelines (NABH and JCI) for Hospital Infection Control

5. Antibiotic Resistance

a. History of Antibiotics

b. How Resistance Happens and Spreads

c. Types of resistance- Intrinsic, Acquired, Passive

d. Trends in Drug Resistance e. Actions to Fight Resistance f. Bacterial persistence

g. Antibiotic sensitivity h. Consequences of antibiotic resistance

i. Antimicrobial Stewardship- Barriers and opportunities, Tools and models in hospitals

6. Disaster preparedness and management-

The objective of this section will be to provide knowledge on the principles of on-site disaster management. Concepts to be taught should includea. Fundamentals of emergency management,

b. Psychological impact management, c. Resource management, d. Preparedness and risk reduction, e. Key response functions (including public

health, logistics and governance, recovery, rehabilitation and reconstruction), information management, incident command and institutional mechanisms.

II Radiographic and Image processing Techniques

1. The photographic process: Introduction, visible light, images produced by radiation, light sensitive photographic materials.

2. Image characteristic: Real and mental images, reflected, transmitted and emitted light images Photographic emulsions. The photographic latent image. Positive process 3. Film materials in X-ray departments, history, structure of an x- ray film, single and double emulsion films, types of films, cross over effect.

4. Spectral sensitivity of film material, graininess of film material, speed and contrast of photographic materials.

5. Sensitometry: Photographic density, characteristic curves, features of the characteristic curve.

6. Variation in the characteristic curve with the development. Comparison of emulsions by their characteristic curves. Information from the characteristic curve. The storage of film materials and radiograph; Storage of unprocessed films, storing of radiographs - expiry date, shelf life, storage condition, stock control.

7. Intensifying screens and cassettes. Luminescence: fluorescence and phosphorescence. Construction of an intensifying screen.

8. 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, and quantum mottle.

9. Cassette design, care of cassettes, types of cassettes, and mounting of intensifying screens, loading and unloading of cassettes.

10. Care of intensifying screens, tests to check screen film contact and light leakage.

11. Film processing: Development. The nature of development-manual or automatic. The PH scale.

12. The constitution of developing solutions both in manual and automatic processing and properties of developing chemicals.

13. The development time, factors in the use of a developer, developer activity.

14. Film processing: Fixing and role of a fixing solution. Constitution of the fixing solutions and properties of the constituents.

15. Fixer used in automatic processors. Factors affecting the use of the fixer.

16. Regeneration of fixing solution. Silver recovery from waste fixer or from scrap film and its various methods.

17. Rinsing, washing and drying. Objects of rinsing and washing, methods employed. Methods of drying films.

18. Preparation of solutions and making stock solution.

19. Processing equipment: Materials for processing equipment, processors for manual operation, hangers, control of chemicals temperature by heating and thermostat, immersion heaters as well as cooling methods.

20. Maintenance of automatic processors and common faults.

21. Dark Room: Layout and planning. Dark room construction - Nature of floor, walls, ceiling and radiation protection.

22. Type of entry, door design. Dark room illuminations - white light and safe lighting

23. Dark room equipment and its layout. Location of pass through boxes or cassette hatches.

24. Systems for daylight film handling. Daylight systems using cassettes and without cassettes.

25. The radiographic image: Components in image quality-density, contrast and detail.

26. Unsharpness in the radiographic image. Various factors contributing towards unsharpness - geometric, photographic; motional, mottle, graininess, distortion.

27. The presentation of the radiograph. Identification markers and orientation.

28. Documentary preparation.

29. Viewing accessories: Viewing boxes, magnifiers, viewing conditions. 30. Light images and their recording. The laser imager, CRT cameras, Video-imagers, dry silver imaging.

31. Photo fluorography: cine cameras, cine

32. Cameras for photo flurography. Sensitometric response of fluorography film.

33. Some special imaging processes, Xero-radiography its meaning, technique and applications.

34. Copying radiograph. Its techniques and applications.

35. Subtraction: its techniques applied to radiography as well as its applications.

fluorography, cine film, serial cameras, processing of cine films, flurographic films.

36. Common film faults due to manufacturing as well as due to chemical processing.

37. Management of the quality of the Radiographic images and image quality control.

Practicals:

1. Test to check the x-ray films and screen contact in the cassette

2. Test to check light leakage in the cassette.

3. To prepare a characteristic curve of a radiographic film

4. To check the effect of safe light on exposed as well as unexposed x-ray film

III Clinical Radiography Positioning Part 2

1. Mammography: The Mammography as a clinical diagnostic tool-immobilization and identification techniques positioning techniques for various projections - exposure factorsConventional & Digital studies-quality and advantage- diagnosis and screening- Characteristics of benign and malignant lesions – patient care – female attendant -

interventional procedures - recent advances in mammography techniques -mammotomogram & Sonomammography procedures- advantages & limitations.

2. Ultrasonography/ Doppler studies: Techniques of sonography-selection-Preparations - instructions and positioning of patient for TAS, TVS, TRUS, neck USG and extremities- patient care and maintenance protocols clinical applications display methods –quality image reproducible extend -assurance to patients.

3. CT scan studies acquisition/ protocols /techniques: CT of head and neck – thorax – abdomen – pelvis – musculo skeletal system – spine – PNS Anatomy – clinical indications and contraindications – patient preparation – technique –contrast media-types, dose, injection technique; timing, sequence - image display – patient care – utilization of available techniques & image processing facilities to guide the clinician-CT anatomy and pathology of different organ systems.

4. MRI Scanners: Methods of MRI imaging methods – Head and Neck, Thorax, Abdomen, Musculoskeletal System imaging - Clinical indications and contraindications- types of common sequences effects of sequence on imaging - Protocols for various studies- slice section- patient preparation-positioning of the patient -patient care-calibration - paramagnetic agents and dose, additional techniques and recent advances in MRI -image acquisition-modification of procedures in an unconscious or un co-operative patient -plain studies- contrast studies -special proceduresreconstructions-3D images- MRS blood flow imaging, diffusion/perfusion scans - strength and limitations of MRI- role of radiographer.

5. Angiography and Cine Studies /DSA: Conventional / DSA studies-Abdominal, visceral, peripheral, cerebral and cardiac angiography - arterial/venous anatomy, physiology-clinical indications and contraindications -patient preparation-positioning of the patient -patient carecontrast media - types of contrast -dosage - accessories catheters, guide wires- pressure injectioncontrol of radiographic and fluoroscopic equipment - exposure factors for serial programmesprogramming-injection protocols-outline on each radiological procedure- radiographer’s rolepatient management before -during and after the procedure - venography-interventional angiography in hepatobiliary, GIT, urology and vascular

system- coils/stents etc.- indications and contraindications - role of radiographer-radiation safety.

IV Contrast & Special Radiography procedures

1. Gastrointestinal Tract: Fluoroscopy, general considerations, responsibility of radiographers. Barium swallow, pharynx and oesophagus- Barium meal and follow through - Hypotonic duodenography - Small bowel enema.- Barium Enema routine projections for colon and rectum, colonic activators; double contrast studies; colostomy. Special techniques for specific disease to be examined. - Water soluble contrast media - e.g. gastrograffin studies.

2. Salivary glands: Routine technique, procedure - sialography.

3. Biliary system: a. Plain film radiography. - Intravenous cholangiography.- Percutaneous cholangiography. b. Endoscopic retrograde cholangio-pancreatography (ERCP). - Operative cholangiography. c. Post-Operative Choangiography (T - tube Cholangiography).

4. Urinary system: Intravenous urography- Retrograde pyelography.- Antegrade pyelography.- Cystography and micturating cystouresthrography.- Urethrography (ascending) - Renal puncture.

5. Female reproductive system: Hysterosalpingography.

6. Mammography: Mammography: Basic views, special views, wire localization. - Ductography.

7. Respiratory system: Bronchography: Awareness.

8. Central Nervous System: Myelography. - Cerebral studies. - Ventriculography.

9. Arthrography: Shoulder, Hip, Knee, Elbow

10. Venography Peripheral venography- Cerebral venography- Inferior and superior venocavography - Relevant visceral phlebography.

11. Sinusography: Routine technique and procedure.

12. Tomography: General principles. Estimation, selection of depth of layer. - Layer thickness required for different examination. - Spacing of layers. - Types and advantages of various movements. - Choice of tomographic

movement- exposure factor. - Sequential, horizontal and multi section tomography. - Application of tomography to specific regions.

13. Macroradiography: General principles - Requirement - Equipment - Technique

14. Soft Tissue Radiography: High and low kilo voltage technique; differential filtration- Non - screen technique - simultaneous screen and non -screen technique- Multiple radiography - Uses of soft tissue radiography.

15. High kV Radiography: General principles- Relation to patient dose- Change in radiographic contrast. - Scatter elimination; beam collimation; grid ratio - Speed and type of grid movementRadiographic factor; application and uses.

16. Localization of foreign bodies: General location principles- Ingested; inhaled; inserted; embedded foreign bodies - Foreign bodies in eye- Preparation of the area to be investigated- Appropriate projection for all - Techniques to locate non-opaque foreign body.

Practicals

Positioning and imaging of all kinds of contrast & special radiographic procedures.

V Medical Terminology and record keeping

1. Derivation of medical terms.

2. Define word roots, prefixes, and suffixes.

3. Conventions for combined morphemes and the formation of plurals.

4. Basic medical terms.

5. Form medical terms utilizing roots, suffixes, prefixes, and combining roots.

6. Interpret basic medical abbreviations/symbols.

7. Utilize diagnostic, surgical, and procedural terms and abbreviations related to the integumentary system, musculoskeletal system, respiratory system, cardiovascular system, nervous system, and endocrine system.

8. Interpret medical orders/reports.
9. Data entry and management on electronic health record system.