

COURSE NAME: BACHELOR OF RADIATION TECHNOLOGY

YEAR I

Course Code	Course Title
BOX14102	Biostatistics and Research Methodology
RAD14104	Equipments for Radiography and Processing Techniques
RAD14105	Patient Care in Radiography and C.P.R.
ANT14105	Human Anatomy and Physiology
CSC14105	Fundamentals of Computer Science
ENG14102	Communication for Professionals
RAD14104P	Equipments for Radiography and Processing Techniques (P)
RAD14105P	Patient Care in Radiography and C.P.R. (P)
ANT14105P	Human Anatomy and Physiology (P)

YEAR II

Course Code	Course Title
RAD14201	Basic Physics and Radiation Physics
RAD14202	Radiographic Techniques
RAD14203	Interventional Radiology Techniques
RAD14204	Computed Tomography Techniques and Equipments
RAD14205	Magnetic Resonance Imaging Techniques and Equipments
RAD14206	Radiographic Photography and Image Processing
RAD14201P	Basic Physics and Radiation Physics (P)
RAD14204P	Computed Tomography Techniques and Equipments (P)
RAD14205P	Magnetic Resonance Imaging Techniques and Equipments (P)

YEAR III

Course Code	Course Title
RAD14301	Principles and Planning of Radiotherapy
RAD14302	Nuclear Medicine Imaging Techniques
RAD14303	Radiation Hazards, Protection and Control
RAD14304	Radiotherapy Techniques and their Recent Advancements
RAD14305	Medical Imaging Informatics
RAD14302P	Nuclear Medicine Imaging Techniques (P)
RAD14303P	Radiation Hazards, Protection and Control (P)
RAD14304P	Radiotherapy Techniques and their Recent Advancements (P)
RAD14305P	Medical Imaging Informatics (P)
TRN14301	Hospital Training

SYLLABUS

YEAR I

Biostatistics and Research Methodology – BOX14102

UNIT	CONTENT
1	Introduction to Biostatistics: Biostatistics; Research Methodology; Types of Variables - Dependent and Independent Variables, Categorical and Continuous Variables; Scales of Measurements - Nominal Scale of Measurement, Ordinal Scale of Measurement, Interval Scale of Measurement, and Ratio Scale of Measurement; Measures of Central Tendency - Arithmetic Mean, Median, Mode; Dispersion – Rates, Ratio, Proportion, and Incidence & Prevalence.
2	Sampling: Random Sampling; Non-random Sampling - Types of Non-probability Sampling, When to use Non-probability Sampling; Various Methods of Sampling - Simple Random Sampling (SRS), Stratified Sampling, Systematic Sampling, Cluster Sampling, Multistage Sampling; Sampling and Non-sampling Errors and Methods of Minimizing these Errors - Sampling Errors, Non-sampling Error.
3	Basic Probability Distributions and Sampling Distributions: Concept of Probability Distribution - Probability Distributions; Normal, Poisson and Binomial Distributions - Normal Distributions, Poisson Distributions, and Binomial Distributions; Concept of Sampling Distributions; Standard Error and Confidence Intervals - Confidence Intervals; Reference Intervals and Clinical Decision Limits; and Skewness and Kurtosis.
4	Tests of Significance: Basic of Testing of Hypothesis - Null Hypothesis, Alternate Hypothesis, Type I and Type II Errors, Level of Significance, Power of the Test, and p-Value; Tests of Significance - t-Test, Chi Square Test, and Test of Proportion; One-way Analysis of Variance; Repeated Measures Analysis of Variance; Non-parametric Tests of Significance - Mann-Whitney U-test, Wilcoxon Test, Kruskal-Wallis Analysis of Variance, and Friedman's Analysis of Variance.
5	Correlation and Regression: Pearson and Spearman's Testing the Significance of Correlation Coefficient; Linear and Multiple Regression - Multiple Regression.
6	Sample Size Determination: Sample Size for Estimating Means and Proportion; Testing of Difference between Means; Testing the Difference between Proportions.
7	Study Designs: Descriptive Studies - Five "W" Questions, Types of Descriptive Studies, Uses of Descriptive Studies, and Advantages and Disadvantages of Descriptive Studies; Analytical Epidemiological Methods - Cohort Study, Case Control Studies; Clinical Trials and Intervention Studies - Intervention Study, Basic Aspects of an Intervention Study, Typical Aspects of Clinical Trials, and Intervention Studies on Group Level; Odds Ratio and Relative Risk - Odds Ratio (OR), Relative Risks; Stratified Analysis - Simpson's Paradox, Mantel-Haenszel Methods.
8	Multivariate Analysis: Concept of Multivariate Analysis – Purpose, Basic Analysis, and Four Types of Research Questions; Multiple and Logistic Regression; Survival Analysis; Evaluation of Validity and Reliability – Reliability, Validity, and Validity and Reliability Compared.
9	Format of Scientific Documents: Structure of Research Protocol - Structure of a Research Protocol; Structure of Thesis/Research Report - Common Thesis Structures, Abstracts, Introductory Chapters, Methods Chapters (in Type 1 Structures), Results, Discussion and Conclusion Chapters, Conclusion Chapters (Type 1 & Type 2 Structures); Formats of Reporting in Scientific Journals - Section Headings, Title, Authors' Names and Institutional Affiliations, and Format; Systematic Review and Meta Analysis - 8 Stages of a Systematic

	Review and Meta Analysis.
10	Research Methodology: An Introduction: Research – Characteristics, Types of Research; Steps of Research Process - Formulating the Research Problem, Extensive Literature Survey, Development of Working Hypotheses, Preparing the Research Design, Determining Sample Design, Collecting the Data, Execution of the Project, Analysis of Data, Hypothesis Testing, and Preparation of the Report or the Thesis; Reviewing the Literature – Structure, Determining Your Topic, Finding the Literature, Tips on Reading, When do you Start Writing?; The Formulation of the Aim and Objectives – Aims, Objectives; Use of the Medical Database - Create the Basis for the Historical Record, Support Communication among Providers, Anticipate Future Health Problems, Record Standard Preventive Measures, Identify Deviations from Expected Trends, Provide a Legal Record and Support Clinical Research.
11	Reporting the Findings of the Research: Writing the Research Report - Importance of Research Reports, Types of Research Reports, Guidelines for Writing a Report, Approaches to Report Writing, and Steps in Writing Report; Presentation of Report - Oral Report, Written Report.

Equipments for Radiography and Processing Techniques – RAD14104

UNIT	CONTENT
1	Electric Supply and Distribution: Diagnostic X-ray Circuits - X-ray Tube, Transformer, The Tube Stand, and Control Panel; Rectification; Incoming Line Current (Phases) - Single Phase and Three Phase Modes, Three Phase 6-pulse Mode, Three Phase 12-pulse Mode; Specialized X-ray Generators.
2	Exposure Timers/AEC: Electronic Timer; Automatic Exposure Control (AEC) Timer; Phototimer; Iontomat; Percentage Tube Overload Indication; X-ray Tube Overload Protection Circuits; and Loadix.
3	Cassettes: Radiographic Film Cassette - Functions of Cassette, Features of an Ideal Cassette, Structure of a Cassette, and Care and Maintenance of Cassettes; Types of Cassettes; Loading and Unloading a Cassette; X-ray Grid; Types of X-ray Grids - Linear/Parallel, Linear/Focused, Crossed (Criss-Cross, Cross-Hatched), Moving Grid Mechanism; Effect on Radiation Exposure.
4	Intensifying Screens and Radiographic Film: Intensifying Screens - Structure of Intensifying Screen, Advantages of the use of Intensifying Screens, Screen Speed, Phosphor, Types of Intensifying Screens, Care of Intensifying Screens; Radiographic Film - Structure and Construction of Film, Composition of Radiographic Films, Types of Radiographic Screen Films, and Handling of Exposed and Unexposed Films.

5	Diagnostic X-ray Tubes, Tube Ratings and Tube Support: Diagnostic X-ray Tubes - Stationary and Rotating Anode X-ray Tubes, Grid Controlled X-ray Tube, Mammography X-ray Tubes, Heavy Duty X-ray Tube, and Micro-focus X-ray Tube; Tube Rating and Tube Supports - Tube Heat Ratings, Line Focus Principle, Anode Cooling Chart, Types of X-ray Tube Stands.
6	X-ray Tables/Bucky and LBD: Floating Top Table - Variable Height Table; The Vertical Bucky and Versatile Bucky - The Primary Beam/Light Beam Diaphragm.
7	Equipments for Fluoroscopy: Fluoroscopic Equipment - Spot Film Device, Flat Panel Direct Fluoroscopy Systems, Television Cameras, Vidicon Camera Tube, and Plumbicon Camera Tube; Cine Fluorography - Mode of Operation, Cine Pulsing, Automatic Brightness Control, and Quality Assurance Tests for fluoroscopic Equipment.
8	Equipment for Mobile Radiography: Equipment for Mobile Radiography - Portable Units, Mobile Units, Capacitor Discharge Unit, Cordless Mobiles, Mobile Image, Intensifier, Limitations; Equipment for Film Processing - Functions of Various Components, Film Roller Transport and Transport Time, Transport Time, Film Feed System, and Care and Maintenance.
9	Equipment for Dental Radiography: Intraoral Radiographic Unit - Intraoral Technique, Orthopantomograph, and Cephalostat; Equipment for Skull Radiography - Types and Principles of Skull Radiography Equipment, Cone-beam Computed Tomography, Computed Tomography, Magnetic Resonance Imaging, and Accessories of Dental Radiography.
10	Dark Room: Processing Area of Dark Room - Dark Room Design, Illumination, Entrance Safe Lighting, Types, Shelving and Storage of Films, and Cleaning and Maintenance of Dark Room; Film Processing – Principles, Processing Cycle, Film Development and Developer, Fixing and Fixer Solution, Washing, Drying Replenishment, Checking and Adjusting, Manual and Automatic Processing, Silver Recovery, and Auto and Manual Chemicals.

Patient Care in Radiography and C.P.R. – RAD14105

UNIT	CONTENT
1	The Radiographer as a Member of the Health Care: The Radiology Team; Ethical and Medico Legal Consideration; Code of Ethics - Scope of Professional Practice; Patient Rights; Malpractice.
2	Attitudes and Communication in Patient Care: The Health-Illness Continuum; Communication with Patients - Relationships with Patients and Carers; Relationships with Service Users; Relationships with Professional Staff - Personal & Professional Standards,

	The Scope of Professional Practice; Relationships with Other Health Care Staff; Dealing with Dying and Death; Challenges in Communication; Children and Adolescents; Geriatric Patients; Altered States of Consciousness; Guidelines for Communicating with Patients and their Families - Techniques for Communicating with Patients, Interviewing Techniques, Therapeutic Communication; Nursing Intervention with Patients with Special Communication Needs; Problems-oriented Medical Recording.
3	Safety, Transfer and Positioning: In Case of Fire - Fire Hazards, Fire Response; Body Mechanics; Transfers - Wheelchair Transfers; Positioning and Ambulating the Adult Patient; Skin Reactions From Radiation Therapy - Caring for your Skin during Radiation Therapy; Bed Rails; Immobilization Methods; Accident and Incident Reporting and Investigation - Resources and Competencies.
4	Evaluating and Meeting Physical Needs: Role of a Physician; Noting the Vital Signs – Temperature, Pulse, Respiration, and Blood Pressure.
5	Infection Control: The Cycle of Infection; Infectious Microorganisms; Transmission – Reservoir, Susceptible Host; Practical Asepsis - Handling Linen; Environmental Asepsis - Disposal of Contaminated Waste, Need for Proper Disposal; Isolation Techniques; Surgical Asepsis.
6	Medication and their Administration: Role of a Radiographer; Medication Information and Administration - Routes of Administration, Intravenous Medication; Charting.
7	Dealing with Acute Situations: Accident Victims; Head Injury – Concussion, Cerebral Compression, Skull Fracture; Spinal Injury; Wounds and Bleeding; Burns; Oxygen Administration; Respiratory Arrests; Heart Attack; Cardiac Arrest; Postural Hypotension and Vertigo; Seizures in Adults; Diabetic Coma and Insulin Reaction - Ketoacidotic Coma, Hyperosmolar Coma, Hypoglycemic Coma, Insulin Reaction; Asthma.
8	Preparation and Examination of the Gastrointestinal Tract: Introduction to Gastrointestinal Tract; Preparation for Examination of GI Tract; DIET; Cathartics; Enemas; Contrast Media for Gastrointestinal Tract; Barium Sulphate; Iodinated Media - Chemistry of Iodinated Contrast Media, Risk Factor Contrast Reactions, and Patient Selection, Preparation and Special Circumstances; Examination of Lower Gastrointestinal Tract; Barium Enemas Double Contrast Barium Enemas; Upper Gastrointestinal Studies; Routine Upper Gastrointestinal Studies; Double Contrast Gastrointestinal Studies; Hypotonic Duodenography; Ensuring Compliance with Preparation Orders; Follow up Care; and Scheduling Sequencing of Examination.
9	Contrast Media and Special Imaging Techniques: Iodinated Contrast Media; Aqueous Iodinated Compound for Intravascular Injection; Reaction to Contrast Media; IVU; Cystography; Contrast Examination of Biliary System; Oral Cholecystography; Intravenous Cholangiography; Other Common Contrast Examination; Myelography; Contrast Arthrography; Bronchography; Angiography; Skin Preparation; Special Imaging Techniques; Computed Tomography; Diagnostic Medicine Sonography; Nuclear Medicine; and Mammography.
10	Besides Radiography Special Condition and Environment: Introduction; Mobile Radiography; Orthopaedic Traction; Orthopaedics Bed Frames; The ICU; Closed Chest Drainage; Swan Ganz Catheters; The Surgical Suite.
11	CPR: History of CPR; Introduction to CPR; Agonal Respiration; Medical Uses of CPR; Defibrillation; Perfusing – Measurement; Returning of Spontaneous Circulation (ROSC).
12	Management of CPR: Community CPR; Positioning Victims; Steps in Determining Care of a Victim - Rescue Breathing, CPR (Cardiopulmonary Resuscitation); Signals of Heart Attack; Infant CPR.
13	Complications of CPR: Introduction to Complications in CPR - Rib Fractures, Bleeding in the Anterior Mediastinum; Heart Contusions; Hemopericardium; Upper Airways Complications; Damage to Abdominal Vicus; Fat Emboli; Pulmonary Complications – Pneumothorax, Hemothorax.

HUMAN ANATOMY AND PHYSIOLOGY – ANT14105

UNIT	CONTENT
SECTION A – HUMAN ANATOMY	
1.	<p>Introduction: Human body as a Whole: Brief introduction about living system; General Anatomy - Definition of anatomy, and its divisions; Terms of positions, planes relationship and movements; Body regions; Body cavities; Membranes –Cutaneous, Serous, Mucous And Synovial membranes; Some clinical terms used in anatomy; General histology: definition, Electron microscopic structure of Human cell; Tissues - Classification, functions and Microscopic Structures of Primary tissues -Epithelial tissue, connective tissue, muscular tissue & Nervous tissue; Glands- Classification, microanatomy of serous & mucous glands with examples.</p>
2.	<p>Locomotion and Support: Skeletal System - Brief introduction about skeletal system, Organizations of skeleton, classification of skeleton: Axial skeleton & appendicular skeleton; Functions of Skeleton; Bones: definition, Classification of bones, Bone growth; Brief study on individual bones: Clavicle, Scapula, Humerus, Radius, Ulna, carpals, metacarpals, phalanges, Hip bones, Sacrum, femur, tibia, fibula, tarsal, metatarsals and phalanges; ribs and sternum; Skull bones - Importance of sutures: coronal, saggital and lamboid, cranial fossae, Bones of Cranium, Mandible and Maxilla. Difference between foetal and adult skull, Structure of typical and atypical vertebrae; Cartilage: definition and its classifications, applied anatomy of cartilage; Joints: Definition, Classification of joints with examples, Synovial joint, Movements & mechanism of Joints, Joint positions, Applied aspects- Arthritis, Spondylitis, Neuropathic Joint, etc; Muscular system: Definition, Classification of muscular tissue, Characterization of – Skeletal, Smooth & Cardiac muscles, Names & action of Skeletal muscles of the body; Appendicular muscles: General overview about muscles that move -a) Pectoral Girdle b) Shoulder Joint c) Elbow Joint d) Wrist Joint e) Intrinsic Muscles of Hand f) Muscles of Hip, Thigh, Leg and Intrinsic Muscles of Foot; Axial muscles: General overview about muscles of-- a) Respiration-Diaphragm and Intercostal, b) Abdominal Muscles, c) Muscles of Facial Expression, d) Muscles of Mastication, e) Muscles of Head and Neck: Histology of-Compact bone (TS & LS), 3 types of cartilage & skeletal (TS & LS), smooth & cardiac muscle.</p>

3.	<p>The Cardiovascular System: General considerations about basics of Cardiovascular System; Gross anatomy & related applied aspects of – Heart: Location- Mediastinum; Shape and Size of Heart, Pericardium, Chambers, Exterior & Interior, Blood supply of heart, Systemic & pulmonary circulation, Conducting system of heart; Major arteries - Branches of aorta, common carotid artery, subclavian artery, axillary artery, brachial artery, superficial palmar arch, femoral artery, internal iliac artery, Peripheral pulse; Major veins - Inferior vena cava, portal vein, portosystemic anastomosis, cephalic vein, Great saphenous vein; Histology of – Elastic Artery, Muscular Artery & Vein. The Lymphatic system: General consideration of Lymphatic system, Gross anatomy of - Cisterna Chyli & Thoracic Duct, Brief discussion over names of regional lymphatics, axillary and inguinal lymph nodes; Histology of –Lymph Node, Spleen, Tonsil & Thymus.</p>
4.	<p>The Respiratory System: Definition and general consideration; Gross anatomy & related applied aspects of – Parts of Respiratory System- Nose, Nasal Cavity, Larynx, Trachea, Lungs, Bronchopulmonary Segments, Pleura; Histology of- trachea and lung.</p>
5.	<p>The Gastro-intestinal System: Definition and brief introduction; Gross anatomy & related applied aspects of – Parts of GIT, Oral cavity (Lip, Tongue, Tonsil, Dentition), Salivary glands- types, location, structure and function, Pharynx- muscles, action and their nerve supply, Oesophagus, Stomach, Small and Large Intestine, Liver, Gall Bladder and Pancreas; Histology of – Tongue, Oesophagus, Stomach, Small And Large Intestine, Liver, Gall Bladder & Pancreas.</p>
6.	<p>The Urinary System: Definition and brief introduction; Gross anatomy & related applied aspects of – Kidney, Ureter, Urinary Bladder, Male and Female Urethra; Histology of-Kidney, Ureter & Urinary Bladder.</p>
7.	<p>The Reproductive System: Definition and general consideration; Gross anatomy & related applied aspects of – Parts of male reproductive system, Testis, Epididymis, Vas Deferens, Seminal vesicles, Prostate and accessory organs, Parts of female reproductive system, Uterus, Fallopian Tubes, Ovary, Mammary Gland and accessory organs; Histology of –Testis, Prostate, Uterus, Fallopian Tubes and Ovary.</p>
8.	<p>The Nervous System: Definition and meaning; Structure of a Neuron; Classification of Nervous System; Gross anatomy & related applied aspects of – Central nervous system: Cerebrum- General consideration, layers of cerebrum, lobes, gyri, sulci, specialized areas, names of basal nuclei and their functions, lateralization of brain; Cerebellum- location, lobes, fissures, deep cerebellar nuclei, functions of cerebellum; Brainstem- location & brief discussion over nuclei of Midbrain, Pons & Medulla Oblongata; Spinal Cord – extension, diameter, organization of grey and white matter, pyramidal and extrapyramidal pathway, important ascending pathways , spinal cord trauma and disorders; Autonomic nervous system- definition, divisions of ANS, brief discussion over pre and post ganglionic nerve fibres; Peripheral nervous system- 1) Cranial nerves- names and functional components and nerve injuries; 2) Spinal nerves- structure of a typical spinal nerve and nerve plexus-Brachial and lumbar plexuses; Segmental innervations of skin; Neurotransmitters; Meninges; Dural venous sinuses; Ventricles; Cerebrospinal fluid; Blood supply of brain; Histology of - Cerebrum, cerebellum & spinal cord.</p>
9.	<p>The Endocrine System: Definition and general consideration of endocrine system; Gross anatomy & related applied aspects of – Pituitary Gland, Thyroid Gland, Parathyroid Gland, Suprarenal Gland and Pineal Gland; Histology of- Pituitary, Thyroid & Suprarenal Glands.</p>
10.	<p>The Sensory Organs: Introduction and brief discussion; Gross anatomy & related applied aspects of – i) Eye-Parts of eye & lacrimal apparatus, Extra-ocular muscles- their nerve supply & action, Visual pathways and related applied. ii)Ear- Parts of ear- external, middle and inner ear and their contents, Auditory pathway and related applied iii) Skin- layers of skin and types of skin; Histology of- Skin- thick and thin skin, Cornea & Retina.</p>
11.	<p>General Embryology: Definition and brief discussion of Embryology; Structure of Ovum & Sperm; Mechanism of Gametogenesis; Fertilization; Brief overview on – a) Cleavage of zygote; b) Blastocyst Formation; c) Implantation; d) Bilaminar Germ Disc; e) Gastrulation; f) Neurulation; g) Development of somites; h) Organogenesis. i) Folding of embryo; j) Germ layer derivatives; k) Placenta; l) Parturition; m)Amnion & amniotic fluid; n)Yolk sac; o) Allantois; p) Multiple pregnancies.</p>

SECTION B – PHYSIOLOGY

12	<p>Introduction to Physiology: The Unit of Life - Description of a cell and its components; Ion channels, receptors and carriers; Intercellular connections; intercellular communications; Functions of a cell. Movement of substances and homeostasis – movement of substances within the body, homeostatic control systems; Basics about different organs and systems.</p>
13	<p>Blood: Composition and functions of blood; Plasma proteins – normal values, origin and functions; Brief idea on Bone Marrow; Formed elements of blood – origin, formation, functions and fate; Hemoglobin – functions, compounds and derivatives; Abnormal hemoglobin-overview; Thalassemia-brief idea; Different types of anemia and their causes-overview; Erythrocyte sedimentation rate (ESR) and its significance; Hematocrit; PCV; MCV; MCH; MCHC; Blood volume – normal values, regulation; Blood coagulation – factors, process; anticoagulants; Prothrombin time; Clotting time; Bleeding time; Blood groups – ABO systems and Rh factors; Blood transfusion.</p>
14	<p>Gastrointestinal System: Characteristics of G.I wall; Neural control of G.I function; G.I. Hormones; Saliva - Composition, Functions, control of secretion; Gastric juice - Composition, mechanism of secretion, functions, regulation of secretion, mucosal barrier; Pancreatic juice - Composition, functions, regulation; Liver & Gall Bladder: Composition & functions of bile, control of secretion, functions of gall bladder, gall stones, enterohepatic circulation, jaundice, functions of liver & L.F.T; Small intestine - Composition & regulation of secretion and functions of intestinal juice.</p>
15	<p>Respiratory System: Functions of respiratory system; Mechanics of respiration; Lung volumes and capacities - definition, normal values, their measurement and clinical importance; Pulmonary ventilation; alveolar ventilation; dead space; Diffusion of gases across alveocapillary membrane; diffusing capacity; Pulmonary circulation; Oxygen & carbon dioxide transport in blood; Pressure changes during ventilation, pressure volume relationship including surfactant and compliance, airway resistance; Control of respiration - neural control, chemical control, response to exercise, periodic breathing; Lung function tests.</p>
16	<p>Nerve Muscle Physiology: Electrical properties of cell membrane; Membrane Potential (MP) - Development and maintenance of MP, Action Potential (AP); Physiology of nerves and neuromuscular junction; Neuro muscular transmission; Functional anatomy of skeletal muscle; Mechanism of muscle contraction and relaxation; isotonic & isometric contraction; energy sources and metabolism; motor unit; Involuntary muscles - Cardiac and smooth muscles.</p>
17	<p>Cardiovascular System: Structure and properties of Heart muscles and nerve supply of Heart; Structure and functions of arteries, capillaries and veins; ECG - leads, principles of normal recording, normal waves & internal & their interpretations, clinical uses of ECG; Cardiac cycle and Heart sound; Factors affecting Heart Rate and its regulation; Cardiovascular reflexes; Blood pressure and its regulation; physiological variation; peripheral resistance; Factors controlling Blood Pressure; Haemorrhage & Shock; Ultra structure & functions of blood vessels (artery & vein). Structure type and function of capillaries; Differences between artery & vein.</p>
18	<p>Excretory System: Functional anatomy of kidney; nephron-structure, parts, function, types; Juxtaglomerular apparatus; Glomerular filtration - filtration barrier, forces governing filtration, measurement; Tubular functions- reabsorption, secretion, Tm values; Regulation of ECF – volume; osmolarity and electrolytes; Acid base balance; Micturition, Renal function tests, renal clearance, abnormal constituents of urine.</p>
19	<p>Endocrine & Reproductive System: General considerations – Endocrine glands and hormones; Structure and function of pituitary (anterior and posterior) gland; Thyroid; Para-Thyroid; Adrenal Cortex, Adrenal Medulla; Thymus and Pancreas; Blood Sugar regulation; General consideration of Reproduction - Development of Puberty; Male Sex Hormones; Spermatogenesis; Female Sex Hormones; Menstrual cycle; Ovulation; Pregnancy and Lactation; Function of Placenta.</p>
20	<p>Nervous System and Special Senses: Electron microscopic structure of nerve cell or neurons; Neuroglia; Myelinated and unmyelinated nerve fibers; Conduction velocity of</p>

<p>nerve impulse in relation to myelination and diameter of nerve fibers; Properties of nerve fibers – excitability, conductivity, all-or-none law, accommodation, adaptation, summation, refractory period; indefatigability; Synapses – types, structure, synaptic transmission of the impulse; synaptic potentials; neurotransmitters; Injury to peripheral nerves – degeneration and regeneration-brief idea; Brief about central nervous system and its function with special reference to cerebral and visual cortex; Automatic nervous system</p> <p>– Introduction, Comparison of autonomic & somatic nervous system, Anatomy of autonomic motor pathways – Pre-ganglionic neurons, autonomic ganglia, sympathetic ganglia, autonomic plexus, post-ganglionic neurons structure of sympathetic and parasympathetic division; ANS - neurotransmitter and receptors-cholinergic neurons & receptors; Receptor agonist & antagonist; Physiological effect of ANS sympathetic & parasympathetic response; Integration & control of autonomic function; autonomic Reflexes; autonomic control by higher centers; sensory physiology of taste and smell organ.</p>
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HUMAN ANATOMY AND PHYSIOLOGY (P) – ANT14105P

1. Histology

- a) Histotechniques
- b) Microscope
- c) Epithelium
- d) Histology of Skeletal muscle
- e) Histology of Cardiac muscle
- f) Histology of Smooth muscle
- g) Histology of Bone
- h) Histology of Hyaline cartilage
- i) Histology of Elastic cartilage
- j) Histology of Fibro cartilage
- k) Histology of artery
- l) Histology of Vein
- m) Histology of Lung

- n) Histology of Trachea
- o) Histology of Lymph node
- p) Histology of Spleen
- q) Histology of Thymus
- r) Histology of Tonsil
- s) Histology of Tongue
- t) Histology of Serous gland
- u) Histology of Mucous gland
- v) Histology of Oesophagus
- w) Stomach (Fundus)
- x) Histology of Stomach (Pylorus)
- y) Histology of Duodenum
- z) Histology of Jejunum
- aa) Histology of Ileum
- bb) Histology of Large intestine
- cc) Histology of Appendix
- dd) Histology of Liver
- ee) Histology of Gall bladder
- ff) Histology of Pancreas
- gg) Histology of Testis
- hh) Histology of Prostate gland
- ii) Histology of Ovary
- jj) Histology of Uterus
- kk) Histology of Fallopian tube
- ll) Histology of Pituitary gland
- mm) Histology of Thyroid gland
- nn) Histology of Adrenal glands
- oo) Histology of Kidney
- pp) Histology of Ureter
- qq) Histology of Urinary bladder

2. Osteology

- a) Appendicular skeleton
- b) Axial skeleton

3. Specimen

- a) Heart
- b) Lung
- c) Larynx
- d) Skin

- e) Joint
 - f) Muscle
4. Study and Care of Microscope.
 5. Blood Samples Collection.
 6. Estimation of Hemoglobin.
 7. Determination of Hematocrit.
 8. Hemocytometry - The Counting Chamber.
 9. Hemocytometry- The Diluting Pipettes.
 10. Total RBC Count.
 11. Determination of Red Blood Cell Indices.
 12. Total Leukocyte Counts.
 13. Preparation and Examination of Blood Smear & Differential Leukocyte Count.
 14. Determination of Erythrocyte Sedimentation Rate (ESR).
 15. Determination of Blood Group ABO and RH System.
 16. Determination of Bleeding Time and Clotting Time.
 17. Clinical Examination - Heart Sounds.
 18. Clinical Examination of Radial Pulse.
 19. Measurement of Blood Pressure.

FUNDAMENTALS OF COMPUTER SCIENCE – CSC14105

UNIT	CONTENT
1	Computer Application: Introduction to Computer - Advantages of computers, Limitations of computers, Application of Computer in Different Fields of Life, Computer Generations, and Classification of Computers; Characteristics of computers; Computer System; Input Unit; Output Unit; Central Processing Unit; Storage or Memory Unit - Primary Storage or Main Memory (MM), Memory Unit – Secondary Storage.
2	Computer Organization: Overview of Computer Organization; Central Processing Unit; Control Unit; Arithmetic Unit; Instruction Set - Difference between RISC and CISC; Register; Processor Speed - Higher is not Always Better, Keep-up with Technology, Price is not Everything.
3	Memory: Overview of Storage Devices; Main Memory; Storage Evaluation Criteria - Access Time, Memory Cycle Time, Effective Access Time; Memory Organization - Addressing Strategies, Organization of Memory Units, Content-Addressable Memories; Memory Capacity; Random Access Memories; Read Only Memory; Secondary Storage Devices; Magnetic Disk; Floppy and Hard Disk - Floppy disk drive, Hard Discs; Optical Disks CD-ROM - Compact disk, DVD, Blu-Ray disk, HD-DVD; Mass Storages Devices; and Differences between the Primary and Secondary Memory.
4	Input Devices: Keyboard; Mouse; Trackball; Joystick - Joystics in aviation, Joystics in Gaming, Analog Joystick, Digital Joystick; Scanner - Characteristics of a scanner, Types of scanner; Optical Mark Reader; Bar-code reader - Types of barcode; Magnetic Ink Character Reader (MICR); Digitizer; Card reader; Voice recognition; Web Cam; and Video Cameras.
5	Output Devices: Monitors - Characteristics of VDU, Types of VDU; Printers; Dot Matrix Printers; Inkjet Printers; Laser Printers; Plotters; Computers Output Micro Files (Com) - COM to CD Service, What Are the Benefits of COM?; Multimedia Projector - Criteria to evaluate suitable Projector.

6	Operating System: Microsoft Windows - An Overview of different version of windows, Basic Windows Elements, File Management through Windows 7; Using Essential Accessories - Disk Cleanup and Disk Defragmenter, Entertainment, Calculator, Note pad, Paint, Wordpad, Recycle Bin, Windows Explorer, and Creating Folder Icons.
7	Word Processing: Word Processing Concepts; Working with Documents - Create a New Document, Opening an Existing Document, Saving a Document, Renaming Documents, Working on Multiple Documents, Document Views, and Close a Document; Working with Text in Word - Selecting text, Editing Text, Finding and replacing text; Printing Documents; Formatting - Bullets and Numbering in Word, Alignment, Page designs and Layout, Editing and Proofreading; Working With Graphics - Inserting Clip Art Images, Moving Images in Word, Deleting images in Word, Text wrapping in Word, Creating Lines and Arrows in Word, Drawing Shapes in Word, Adding a Text Box; Working with Tables.
8	Presentation Package: Creating a New and Opening an Existing Presentation; Creating the look of your Presentation; Working with Slides - Adding and formatting Text, Formatting PowerPoint; Printing Handouts with Notes making; Images and Clip Art; Slide Shows.
9	Internet and Email: Definition about the World wide web & brief History; Use of Internet and Email – Internet, Email; Internet – Terminology, Protocols, Routing; Websites; The Mail Protocol Suite; Using Search Engine and beginning Google search; Exploring the next using Internet Explorer and Navigator; Uploading and Downloading of Files and Images; E-mail ID creation - Opening the E-mailbox, Sending Messages, and Attaching Files in E-mails.
10	Hospital Information System: Hospital Information System; Architecture of a Hospital Information System; Aim and Uses of HIS - Aim of HIS, Uses of HIS; Types of HIS; Benefits of using a Hospital Information Systems; Advanced Hospital Management System - XO Hospital Management System, LCS Hospital Management Information System, NVISH Hospital Management System.

COMMUNICATION FOR PROFESSIONALS – ENG14102

UNIT	CONTENT
1	Essentials of Grammar: Parts of Speech; Vocabulary building; Sentence; Articles; Pronouns; Quantity; Adjectives; Adverbs; Prepositions, Adverb particles and phrasal verbs, Verb; Verb tenses; Imperatives; Active and passive voice; Direct and indirect speech; The infinitive; Conditional sentences; Synonyms and antonyms; Singular and Plural; Figures of Speech; Punctuation and Phonetics.
2	Nature, Scope and Process of Communication: Defining Communication; Nature of Communication; Objectives/Purpose of Communication; Functions of Communication; Process of Communication; Elements of Communication Process; Models; Working of

	the Process of Communication; Forms of Communication.
3	Channels and Networks of Communication: Channels of Communication; Communication Flow in Organizations: Directions/Dimensions of Communication; Patterns of Flow of Communication or Networks; Factors Influencing Organizational Communication.
4	Principles of Effective Communication: Communication Effectiveness: Criteria of Evaluation; Seven Cs of Effective Communication; Four Ss of Communication.
5	Barriers in Communication: Categorisation of Barriers; Semantic Barriers; Organizational Barriers; Interpersonal Barriers (Relating to Superior-subordinate); Individual or Psycho-sociological Barriers; Cross-cultural/Geographic Barriers; Physical Barriers/Channel and Media Barriers; Technical Aspects in Communication Barriers; Overcoming the Barriers in Communication; Measures to Overcome Barriers in Communication.
6	Non-verbal Communication: Characteristics of Non-verbal Communication; Relationship of Non-verbal Message with Verbal Message; Classification of Non-verbal Communication.
7	Oral Communication: Informal Conversation: Oral Communication; Informal Conversation; Learning Informal Conversation; How to Go About Learning Other Tricks?; Learning Conversational Skills; Internet Chat.
8	Communication in Business Organizations: Meaning of Business Communication; Types of Information Exchanged in Business Organizations; Role of Communication in Business Organizations; Importance of Communication in Management of Business Organizations; Scope of Communication in Organizational Setting; Characteristics of Effective Business Communication; New Communication Environment; Ethical challenges and Traps in Business Communication; Role of Communication in Three Managerial Roles Defined by Henry Mintzberg.
9	Formal Conversations: Meetings, Interviews and Group Discussions: Meetings; Duties of Participants; Minutes; Interviews; Group Discussions.
10	Greetings and Introduction: Basics of greetings and introduction; formal and informal introduction; Reading comprehension: Vocabulary; Pronunciation: Falling and rising tone; Speaking: Body language; Listening: body language.
11	Listening Skills: Importance of Listening; Listening versus the Sense of Hearing; Listening as Behaviour; Payoffs for Effective Listening; Actions Required for an Effective Listener; Approaches to Listening; Misconceptions and Barriers that Impair Listening; Planning for Effective Listening; How to be a Good Listener?; What Speakers can do to Ensure Better Listening?.
12	Formal and Informal Letters: Distinction between Formal and Informal Letters; Writing Formal Letters; Informal Letters.
13	Communication on the Net: E-Mail; Netiquettes; Blog Writing; Web Writing.
14	Report Writing: Business Reports: Significance; Types of Reports; Five Ws and one H; Report Planning; Report Writing Process; Outline of a Report; Guidelines for Writing Report; Technicalities of Report Writing; Visual Aids in Reports; Criteria used for Judging the Effectiveness of a Report; Illustrations.
15	Job Applications and Resume Writing: Job Application/Covering Letter; Resume/CV Writing.

BASIC PHYSICS AND RADIATION PHYSICS – RAD14201

UNIT	CONTENT
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 volt, Electromagnetic radiation, Quantum nature of radiation, mass energy equivalence, Fluorescence, 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; Magnetism: Magnetic induction; magnetic properties, Hysteresis, magnetic effect of current, Electrical instruments, Galvanometer, voltmeter, ammeter and multimeter.
3	Electromagnetic Induction: Induced electromotive force, Faradays experiments, laws of electromagnetic induction, Self and mutual induction; Alternating current, Ac generator, Peak and RMS values, AC circuits with resistance, capacitance and inductance, Choke coil, eddy current; Transformer, theory, design, losses, auto transformer, high voltage transformer, electric power transmission.
4	X-rays: Discovery of x-rays, properties-production, x-ray spectrum, bremsstrahlung and characteristic x-rays- X-ray tube; Coolidge tube, tube design, line focus principle, space charge effect, tube cooling- Modern x-ray tubes; stationary anode, rotating anode, grid controlled x-ray tubes, heel effect, off focus radiation, tube insert and housing-Tube rating- Quality and intensity of x-rays, factors influencing them.
5	X-ray generator circuits: Vacuum tube diodes-semiconductor diodes-transistor-rectification, half and full wave-self rectification – X-ray generator; filament circuit-kilo voltage circuit-single phase generator-three phase generator -constant potential generator. Fuses, switches and interlocks-Exposure switching and timers-HT cables-earthing.
6	Radioactivity: Discovery of radioactivity, natural radioactivity-activity units- radium, thorium and uranium series- alpha, beta decay and gamma rays - radioactive disintegration-exponential decay, half-life period, decay constant. Artificial radioactivity –production of radioisotopes-cyclotron-neutron-fission and fusion-chain reaction-atom bomb-nuclear reactor.
7	Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, linear attenuation coefficient-coherent scattering-photoelectric effect- Compton scattering-pair production-photonuclear disintegration-Particle interactions. Interactions of x and gamma rays in the body; fat-soft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance.
	Radiation Measurement: Measurement of radiation and dosimetric procedures; Radiation detectors and their principles of working; Definition of Bragg-peak , percentage depth dose, peak scatter factor, tissue air-ratio, tissue; maximum ratio, scatter air ratio, isodose curves and radiation penumbra of different beams.
8	Radiation quantities and units: Radiation intensity-exposure, roentgen, its limitations- Kerma and absorbed dose-electronic equilibrium radiation, gray, conversion factor for roentgen to rad-RBE-LET-quality factor-dose equivalent-rem, sievert.
9	Radiation Physics I: Atomic structure as applied to generation of X-rays and radioactivity spectrum of diagnostic imaging and therapy X ray; Effects of variation of tube voltage current, filtration, Ill waveform and target material on X-ray production lows of radioactivity and decay schemes of different alpha, Beta, gamma ray. Megatron and position emitters as used in medicine especially in radiotherapy; Artificial radionuclide generators employed in medicine in general and radiotherapy sources in particulars; Interaction of radiation with matter attenuation absorption and scattering phenomena.

10	Radiation Physics II: Photoelectric absorption Compton scattering pair-production and annihilation process ionization, 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 amount of scatter from homogeneous and homogenous beam defining the passage through a patient; Physical requirements of beam defining devices e.g. cones, diaphragm, collimators etc.; Units of radiation measurements specification of quality and half- valve thickness (HIV) and its measurements, filters and filtration.
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BASIC PHYSICS AND RADIATION PHYSICS – RAD14201 P

RADIOGRAPHIC TECHNIQUES – RAD14202

UNIT	CONTENT
SECTION A : CONVENTIONAL NON-CONTRAST RADIOGRAPHY	
1	Principles Of Radiography: Preparation Of The Room, Apparatus And Instruments; Positions Of The Patient: Erect, Sitting, Supine, Prone, Lateral, Oblique, Decubitus Etc.; Relative Position Of X-Ray Tube And Patient; Relevant Exposure Factors. Use Of Accessories Such As Radiographic Cones, Grid And Positioning Aids; Radiographic Appearances, Both Normal And Common Abnormal Conditions Where Elementary Knowledge Of The Pathology Involved Will Ensure The Application Of The Appropriate Radiographic Technique; Modifications In Technique For Various Disabilities And Types Of Subject; Radiation Protection, Use Of Gonad Shield, Practical Methods Reducing Radiation Dose To The Patient.
2	Upper limb: Routine Projections For The Whole Hand, Fingers, Wrist Joint, Forearm, Elbow Joint And Humerus. Supplementary Projections For Scaphoid, Carpal Tunnel Ball Catchers Projections, Head Of The Radius, Supracondylar Fracture And Olecranon Process. Lower limb: Routine Projections For The Whole Foot, Toes, Calcaneus, Ankle Joint, Leg, Knee-Joint, Patella And Femurs. Supplementary Projections For Talo-Calcaneal Joint, Forced Projections For Torn Ligaments, Flat Feet, Club Feet, Intercondylar Projections For Loose Bodies In The Knee, Axial Projection For Patella.
3	Shoulder Girdle And Thorax: Routine Projections For The Shoulder Joint, Scapula,

	<p>Acromioclavicular Joint, Clavicle, Sternoclavicular Joint, Sternum And Ribs. Supplementary Projections For The Axial Projection Of Clavicle, Bicipital Groove Carotid Process, Classification Of Tendons, Subluxation, Upper Ribs, Lower Ribs And Axillary Ribs.</p> <p>Pelvic Girdle And Hip Region: Routine Projections For The Whole Pelvis, Sacroiliac Joints, Hip Joint And Neck Of Femur. Supplementary Projections For The Greater And Lesser Trochanters Of Femur. Frog Leg Projection, Ischium Symphysis Pubis, Ilium, Acetabulum And Congenital Dislocation Of Hip Arthrodesis.</p>
4	<p>Vertebral Column: Routine Projections For Atlanto Occipital Joint, Cervical Spine, Cervico Thoracic Junction, Thoracic Spine, Lumbar Spine, Lumbosacral Region, Sacrum And Coccyx. Supplementary Projections For The Intervertebral Foramina, Posterior Arch Of Atlas, Flexion And Extension Of Cervical Spine, Scoliosis And Kyphosis, Sacroiliac Joint.</p>
5	<p>Skeletal Survey: Skeletal Survey For Metabolic Bone Diseases, Metastases, Hormonal Disorders, Renal Disorders.</p> <p>Skull: Routine Projections For Cranium And Facial Bones; Supplementary Projections For Trauma, Towne's & Method, Sella, Turcica, Optic Foramina; Jugular Foramina, Temporal Bones, Mastoids Petrous Bone, Zygomatic Arches, Orbits, Maxillae; Nasal Bones, Mandible, Temporomandibular Joints.</p>
6	<p>Nasal Sinuses: Techniques For Frontal, Maxillary, Ethmoidal And Sphenoid Sinuses, Erect And Horizontal Projections For Fluid Levels.</p> <p>Teeth: Routine Projections Of All Teeth - Intra Oral And Extra Oral Projections. Supplementary Projections For Localisation Of Roots, Children, Edentulous Subjects And Use Of Occlusals And Bitewings, Orthopantomography.</p> <p>Chest: Routine Projections For Lungs, Cardiac And Diaphragm. Supplementary Projections For Opaque Swallow, Thoracic Inlet, Soft Tissue Neck, Decubitus, Paediatric Cases. Abdomen: Kub, Erect Abdomen And Decubitus Projection, Supplementary Projections For Acute Abdomen.</p>
SECTION B : CONVENTIONAL CONTRAST RADIOGRAPHY	
7	<p>Urinary system imaging (IVU, MCU, RGU): Clinical indications and contraindications, patient preparation, contrast media used and dosage , physiological process by which urinary tract is outlined ,film sequence (projection and timing), normal anatomy on films, additional techniques, radiation protection, care of patient during and after examination. Pathological conditions of urinary system: kidneys, ureter, urinary bladder, urethra.</p>
8	<p>Gastrointestinal tract imaging: (Barium swallow, barium meal upper GI, barium meal follow through, barium enema, small bowel enema, distal colography, defecography), clinical indications and contraindications, contrast media used: preparation and dosage , patient preparation, preparation of equipment, control of radiographic and fluoroscopic equipment, film sequence, radiographic projections, radiation protection, patient management, after care of patient, radiographer's role in the team, pathological conditions of the GI tract.</p>
9	<p>Biliary system (PTC, ERCP, T-tube cholangiography, per operative cholangiography): Clinical indications and contraindications, contrast media, patient preparation, film series , radiation protection, patient care, normal anatomy, pathological conditions of biliary system.</p>
10	<p>Sialography and sonography: Clinical indications and contraindications, patient preparation, contrast media and dosage, injection procedure, techniques for radiographic projections, radiographic appearances, radiation protection, patient care, pathological conditions.</p>
11	<p>Hysterosalpingography (HSG): Revision of anatomy and physiology, clinical indications and contraindications, contrast injection, projections, radiation protection, patient care, normal and pathological conditions.</p>
12	<p>Procedures which are obsolete or rarely used: An overview. Myelography: indications and contraindications, contrast used, patient preparation, injection technique, film sequence, projections, patient care, pelvimetry, oral cholecystography /intravenous cholangiography, dacryocystography, arthrography, discography.</p>

SECTION C: CONVENTIONAL - NON CONTRAST, SPECIAL SITUATIONS

13	Paediatric radiography: Anorectal malformation contrast; Intersex disorders, esophageal atresia – pre/post op. intussusceptions; Congenital dislocation of hip; Scoliosis; Leg–length measurements; Assessment of bone age; Non accidental injury; Radiography of babies in incubators.
14	Trauma/Emergency Radiography: Limb fractures, fracture of thoracic cage, spine, skull, GIT obstruction, lung collapse, pleural effusion, pneumothorax, selection of suitable X-ray equipment, patient position, radiographic projections and sequence for each patient, modification of routine positioning, X-ray tube and film, radiation protection, patient care.
15	Operation theatre radiography: Operative cholangiography, orthopaedic procedures, pre-operative chest, strict observation of asepsis, preparation of radiographer and equipment/ accessories, careful safe use of mobile and fluoroscopic equipment, radiation protection, patient care, protection of theatre staff, rapid availability of radiographic image.
16	Mammography: Anatomy and physiology of female breast, knowledge about the nature of X ray beam suitable for breast imaging, equipment suitable for generating such X radiation, image recording devices, accessories for immobilisation and identification, positioning, techniques for various projection, exposure factors, radiation protection, technique of biopsy procedure, characteristics of benign and malignant lesions, patient care, female attendant.

INTERVENTIONAL RADIOLOGY TECHNIQUES – RAD14203

UNIT	CONTENT
1	Introduction : Need for interventional procedures; Informed consent; DSA; Basic Principle; Types; Equipments; Basics of Angiographic equipments; Single and biplane angiographic equipment; Angiographic Table; Image intensifier; Flat panel detector; Recording systems; Pulseoximetry; Cardiac resuscitation measures – ECG; Pressure injector; Catheters, needles and other tools; 3-D rotational angiography; Image processing; Patient monitor; ACT equipment; CO2 angiography.
2	Patient care: Preparation for procedure; Post procedure care; Role of radiographer in interventional procedure; Crash trolley- Emergency drugs.
3	Interventional Procedures: Diagnostic & Therapeutic interventional procedures; PTC, PTBD, Stenting; Nephrostomy, ureteric stenting; Guided biopsies of different organs; Drainage of collections/abscesses; Angiograms, angioplasty, embolization; Venous access; Radiofrequency ablation; Image guided nerve blocks.

4	Neuro interventional procedures: Embolization of extra or intracranial tumors, vascular malformations; Vertebroplasty – direct puncture; Laser guided procedure.
5	Basics of cardiac catheterization: Catheters; Types of catheters and guidewires, Seldinger technique; Digital subtraction angiography; Interventional procedures: Cardiac, Vascular and Nonvascular.
6	Safety considerations in angiography room: Room design; Protective devices; Radiation monitoring.
7	Care, Maintenance and tests: General care; Functional tests; Quality assurance program; Acceptable limits of variation; Corrective action.
8	C.T. Guided procedures: Fine needle aspiration cytology; Fine needle aspiration Biopsy Stereo tactic biopsy; Radio surgery.
9	Ultrasound guided procedures: Fine needle aspiration cytology; Fine needle aspiration - Fine needle aspiration Biopsy.
10	Fluoroscopy guided procedures: Endoscopic Retrograde choledocho-pancreatography; Percutaneous nephrolithotomy; Percutaneous nephrostomy; Percutaneous transhepatic biliary drainage; Angioplasty; Embolisation -Transjugular liver biopsy.

COMPUTED TOMOGRAPHY TECHNIQUES AND EQUIPMENTS **– RAD14204**

UNIT	CONTENT
1	Introduction to Computed Tomography and Principle of Computed Tomography: History, Advantage and Disadvantages of CT, Basic principle of CT.
2	Generations of Computed Tomography: 1st generation, 2nd generation, 3rd generation, Slip ring technology, 4th generation, Electron beam CT, Dual Source CT, Flat Panel Detector CT; Single and Multi slice Technology.
3	Instrumentation: CT scanner gantry, Detectors & Data Acquisition System, Generator, Computer and image processing; System Image display system, storage, recording and communication system, CT control console, Options and accessories for CT systems.
4	Image Reconstruction: Basic principle, Reconstruction algorithms, Image reconstruction from projections, Types of data reconstruction.
5	Image Display and Image Quality: Image formation and representation, Image processing, Pixel and voxel, CT number Window level and window width, Qualities, Resolution, Contrast, Sharpness, Noise properties in CT.
6	CT Artifacts: Classification, Types, Causes, Remedies.
7	Diagnostic aspects of CT and post Processing Techniques: HRCT, Isotropic imaging,

	Patient management, Patient preparation, positioning, Technologist role, Protocols for whole body imaging; Clinical applications of CT, 2D & 3D imaging, MPR, SSD, Volume Rendering.
8	Advanced CT: CT angiography, volumetry, bowel studies, virtual bronchoscopy and colonoscopy, CT enterography.
9	Miscellaneous: Handling difficult patients, Contrast in renal disease patient, contrast dose modulation Handling emergencies.

MAGNETIC RESONANCE IMAGING TECHNIQUES & EQUIPMENTS – RAD14205

UNIT	CONTENT
1	Introduction and Basic Principle of Magnetic Resonance Imaging: History of MRI , Electricity & Magnetism, Laws of magnetism, Atomic structure, Motion within the atom, The Hydrogen nucleus, Precession, Larmor equation, Resonance, MR signal, Free induction decay signal, Relaxation, T1 recovery, T2 decay, Pulse timing& parameters.
2	MRI Hardware: Introduction, Permanent magnets, Electromagnets, Super conducting magnets, Fringe fields, Shim coils, Gradient coils, Radio-frequency coils, the pulse control units, Patient transportation system, Operator interface.
3	Encoding, Data collection & Image formation: Introduction, Gradients, Slice selection, Frequency encoding, Phase encoding, Scan timing, Sampling, data space, k-space, k-space filling and fast Fourier transformation.
4	Pulse sequences: Introduction To basic pulse sequences; Spin echo sequences, Conventional spin echo, Fast spin echo; Inversion recovery, STIR, FLAIR; Proton Density Imaging; Gradient echo pulse sequences; Conventional gradient echo, The steady state, SSFP, Coherent residual transverse magnetization, Incoherent residual transverse magnetization, Ultra- fast imaging, Advanced imaging techniques, EPI.
5	MRI parameters & Tradeoffs: Introduction, Signal To Noise Ratio (SNR) & How to increase SNR, Contrast to Noise Ratio (CNR), Spatial resolution & how to increase the

	spatial resolution, Scan time & how to reduce time, Tradeoffs, Decision making, Volume imaging.
6	MRI Artifacts: Introduction, Phase miss-mapping, Aliasing or wrap around, Chemical shift artifact, Chemical misregistration, Truncation artifact/Gibbs phenomenon, Motion of the patient; Magnetic susceptibility artifact, Magic angle artifact, Zipper artifact, shading artifact.
7	MRI contrast agents: Introduction, Uses and methodology, Review of weighting, Mechanism of action, Dipole-dipole interactions, Magnetic susceptibility, Relaxivity; Gadolinium safety, Feridex safety, Current applications of contrast agents.
8	Flow Phenomena & MRI angiography: Introduction, The mechanisms of flow, Time of flight phenomenon, Entry slice phenomenon, Intravoxel dephasing; Flow phenomena compensation; Gradient moment rephrasing, Pre saturation, Even echo rephrasing, MR Angiography.
9	Clinical Applications, Scanning Protocols and Safety aspects: Protocols for whole body imaging , The main magnetic field, Gradient magnetic field, Radiofrequency fields, Projectiles, Implants and prostheses, Pacemakers, Medical emergencies, Patient monitoring, Monitors and devices in MRI Claustrophobia, Quenching, Safety tips, Layout planning

MAGNETIC RESONANCE IMAGING TECHNIQUES & EQUIPMENTS – RAD14205P

RADIOGRAPHIC PHOTOGRAPHY AND IMAGE PROCESSING – RAD14206

UNIT	CONTENT
1	Dark Room Planning: For A Small Hospital, For A Large Hospital; Location Of Dark Room; Construction Of Dark Room; Ventilation; Wall Protection; Entrance To Dark Room - Single Door, Double Door, Labyrinth.
2	Dark Room: Instruction To Staff; Dry Bench; Hopper, Drawer, Cupboard; Loading And Unloading Cassettes; Hangers, Types Of Hangers And Storage Of Hangers; Printing; Wet Bench; Cleanliness, Control Of Dust, Dark Room Sink; Hatches; Drier; Safe Lights, Direct

BACHELOR OF RADIATION TECHNOLOGY - BRT

	And Indirect, Uses, Factors Affecting Safelight Performance, Safelight Tests; Viewing Room, Film Dispensing.
3	X-Ray Films: Glass, Cellulose And Polyester Bases; Structure Of X-Ray Films - Emulsion, Gelatin, Base And Supercoating; Types Of X-Ray Films; Single Coated, Duplitised; Spectral Sensitivity Colour Sensitivity; Graininess of Films; Speed Of Films; Screen & Non Screen Films; Various Formats Of Films; Films For Special Procedures. Storage Of Film Materials And Radiographs; Record Of Film Stock And Radiographs; Deterioration Of Films On Storage; Characteristic Curves - Uses Of Step Wedge; Information On Basic Fog, Film Gamma, Contrast, Speed, Film Latitude, Effects On; Development.
4	Intensifying Screens: Fluorescence – Phosphors; Phosphors Employed - Calcium Tungstate - Barium Fluorochloride - Rare Earths; Construction Of Intensifying Screens; The Influence Of Kilovoltage In Different Phosphors; Intensification Factor; Resolving Power Of Intensifying Screens; Speed Of Screens; Screen Film Contact Tests; Types Of Intensifying Screens; Advantages And Limitations Of Intensifying Screens.
5	X-Ray Cassette: Construction Of X-Ray Cassettes; Types Of Cassettes; Mounting Intensifying; Screens On Cassettes; Identification Of Cassettes; Care Of Cassettes.
6	Photochemistry: Chemistry Of Image Formation; Formation Of Latent Image; Conversion Of Latent Image To Visible Image; Meaning Of Ph; Importance Of Ph In Processing Films.
7	Processing Methods: Preparation Of Solution; Manual Processing Apparatus; Control Of Temperature; Rapid Processing; Automatic Processor - Principle And Features, Water Supply, Use Of Thermostat, Regeneration Of Solutions, Maintenance, Advantage And Limitations. Processing Of Cut Films And Roll Films. Computer Photography; Digital Radiography - Principles, Processing, Equipments, Advantages; Radiological Information Systems.
8	The Radiographic Image: The Emergent Beam Related To Densities On Film Contrast - Objective And Subjective; Long Scale And Short Scale; Radiation Contrast, Film Contrast And Radiographic Contrast. Density; Sharpness; Sources Of Unsharpness; Avoiding Different Unsharpness. Resolution; Factors Affecting Resolution Choice Of Kilovoltage And Milliampere Choice Of Short Focus; And Broad Focus Selection Of Focus To Film Distance And Object To Film Distance Selection Of Cassettes; Avoiding Scatter Radiation, Magnification, Distortion, Penumbra Presentation of a Radiograph - Identification Markers - Name Printer; Viewing Equipment Magnifiers for Cut Films and Roll Films.
9	Developer: Constituents; Characteristic; Manual and Automatic Processors; Effects on Developing Time, Temperature, Agitation; Replenisher; Exhaustion.
10	Rinsing: Acid Stop-Bath; Methods; Objects.
11	Fixer: Constituents; Characteristics; Manual and Automatic Processors; Fixing Time and Clearing Time; Factors Affecting Fixing Time; Replenisher; Exhaustion
12	Washing and Drying: Objects; Methods; Factors Affecting Washing and Drying; Wetting Agents; Comparison of Different Methods.
13	Day Light Film Handling: Day Light System Using Cassettes; Day Light System without Cassettes
14	Film Faults: Fog - Various Fogging In Films, Causes And Prevention. Stains - Types, Causes And Prevention; Spots And Splashes - Types, Causes And Prevention Marks And Prints - Types, Causes And Prevention Drying Marks - Types, Causes And Prevention Faults In Automatic Processor - Types, Causes.
15	Reproduction Of Radiographs: Copying Radiographs; Magnification and Magnification; Contact Prints; Types Of Paper; Equipment.

YEAR III

PRINCIPLES AND PLANNING OF RADIOTHERAPY – RAD14301

UNIT	CONTENT
1	Radiotherapy planning: Treatment planning; Planning procedure in general with special emphasis on turnout localization and target volume measurement by conventional radiographic method and simulator imaging; Role of special contrast medium base radiotherapy.
2	Role of imaging in treatment: CT/MRI/Ultrasound/ radionuclide imaging methods physical and clinical requirements of field; selection of treatment in Teletherapy, Role of portal films in treatment planning. Choice of central axis percentage depth dose data and isodose curve form a spectrum of radiotherapy beams used treatment; Requirement and practice of organ shielding single multiple fields, and rotational field therapy; planning procedures; Computerized treatment planning system choice of dose, time and fraction.
3	Safety protocols: Safety of critical organs in planning methods, Role of treatment shell immobilization devices and laser in patients set up and positioning; Acceptance tests on therapy simulator telescope megavoltage X-ray and electron beam machines.
4	Technologist's role: Contribution of technologist in radiation calibration of quality control assurance in execution of radiation treatment.
5	OrthoVoltage techniques: Orthovoltage techniques in skin tumours, and cancers of the breast Advantages and disadvantages of orthovoltage in radiotherapy; Tele isotope cobalt therapy techniques in skin and deep sealed tumours parallel opposed fields and small beam directed therapy and wedge field techniques in head and neck tumours especially cancers of larynx treatment techniques for cancer of maxillary antrum and pituitary tumours.
6	Radiotherapy and brachytherapy: Treatment techniques in cancer of breast by telecobalt and low energy megavoltage X-rays and electron beam; Tele and brachy-therapy techniques of treatment of different stages of carcinoma cervix uteri with special emphasis on HDR and LDR brachytherapy. Three field techniques in cancer of esophagus and bladder; Radiotherapy technique in medulloblastoma.
7	Whole body and hemi body radiation techniques: Treatment techniques of malignant and non-malignant conditions in ovarian and kidney tumours; Radiation treatment techniques of lymphomas with special emphasis on mantle field irradiation; radiotherapy techniques in head and neck cancer.
8	Salient features of computers in radiotherapy and its application: Introduction to computer, Hardware and software component; Input and output data systems computerized treatment planning systems in tele therapy and brachytherapy and documentations.
9	Radiological protection: Dose limits of occupational workers & Publics; Principle & Method of Protection; Monitoring devices.
10	Effects of various radiations on normal tissues and malignant tumor: Early and late reaction on Skin, Mucous membrane, GI tract, Genito urinary system, respiratory system, CNS.
11	Introduction to malignant tumor: Basic pathology-Carcinoma: Sarcoma-Lymphoma; Pattern of Spread, Biopsy/Investigations related to malignant tumor-staging work up and TNM.
12	Different malignant tumor treated in radiotherapy department : Introduction of different malignant tumor treated in radiotherapy department including TNM Skin-lip-oral cavity & Para nasal sinus-nasopharynx-orophaynx-hypopharynx-larynx-thyroid-postcricoid—oesophagus-mediastinum- lungs-pancreas-liver-breast- cervix-body of the uterus-vagina-valva-kidney,ureter,bladder,rectum-prostate,penis,testis-lymporeticulam tissue-bone marrow-CNS ,eye, orbit-soft tissue & bone-pediatric tumor, retinoblastoma, wilms tumor, rhabdomyosarcoma.

NUCLEAR MEDICINE IMAGING TECHNIQUES – RAD14302

UNIT	CONTENT
1	Basic atomic & nuclear physics: Quantities and Units; Atom composition and structure; Nucleus composition; Radioactivity; Exponential decay; Specific activity; Parent / Daughter decay; Modes of Radioactive decay.
2	Radiation detectors: Gas filled detectors - Basic principles; Ionization chambers; Proportional counters; Geiger Muller counters; Semiconductor detectors; Scintillation detectors – basic principles
3	Production of Radio nuclides: Reactor produced radionuclide; Reactor principles; Accelerator produced radionuclide; Radionuclide generators.
4	Instrumentation: The Anger Camera; Basic principle; System components; Detector system and electronics; Collimators; Image display and recording systems; Scanning camera.
5	Radio pharmacy: Radiopharmaceuticals; General principle of tracer technique; Preparation of different labeled compounds with technetium-99m isotope; Cold kits.
6	In vivo technique: Static and dynamic studies; Thyroid imaging; Imaging of bone; Respiratory system; Urinary system; G.I. system; Cardiovascular system; Iodine 131 uptake studies; Iodine 131 therapy for thyrotoxicosis and thyroid ablation.
7	Image quality in Nuclear medicine: Spatial resolution; Contrast; Noise; Types of noise; Quality assurance of imaging equipments; Variation in Image perception – with physician, within technologist & technical parameter.
8	SPECT and PET imaging: Imaging methods; mathematical principles; resolution; noise effect; 3D imaging; positron
9	Radiation safety in Nuclear medicine: Radiation units and quantities; MPD; Safe handling of Radioactive materials; Storage of radioactive materials; Procedures for handling spills; Disposal of Radioactive waste; Radiation monitoring; Survey meters; Personnel dosimeters; Wipe testing; Contamination monitor; Isotope calibrator; Area monitor; Inventory of isotopes.

NUCLEAR MEDICINE IMAGING TECHNIQUES – RAD14302P

RADIATION HAZARDS, PROTECTION AND CONTROL – RAD14303

UNIT	CONTENT
1	Radiation protection: Definition of radiation hazards; principle, history & development - National & international agencies; AERB, BARC, ICRP, WHO, IAEA and their role. Equivalent dose-effective dose-sievert-rem. Sources of radiation-natural-man made & internal exposures; Permissible dose levels on and around sealed source housing and installation principles of radiation protection; Different ICRP rules; stochastic and non-stochastic effects; Importance of 'ALARA' physical principles of design and planning of installation safe work practice in teletherapy and brachytherapy.
2	Methods To Reduce Radiation: Wedge filters, wedge angle, hinge angle.. Compensator beams flatter filters, scattering foils; Physical properties of phantom materials, bolus and substitutes; Factor used for treatment dose calculations, Daily treatment time and monitor units calculation; method physical aspects of electron and neutron therapy.
3	Shielding Materials Radiation Survey and Personnel Monitoring Devices: Film badge; TLD badges; pocket dosimeters; Principle of Working, design, advantages and disadvantages of each.
4	Planning of radiation installation: Protection from primary, leakage and scattered radiation. Concepts of work load use factor, occupancy factor & distance. Barrier design-barrier materials-concrete, brick& lead. Primary & secondary barrier design calculations. Design of doors. Control of radiation-effects of time, distance and shielding.
5	Personnel monitoring systems: Principle and objective-film badge-guidelines for use-thermoluminescent dosimeter badge-pocket dosimeter. Area monitoring and radiation survey, practical use of survey meter, zone monitors and phantoms. Survey in teletherapy, brachytherapy and simulator units.
6	AERB safety code and ethics: Built in safety specification for teletherapy and brachytherapy units-treatment room and control room safety-operational safety-radiation protection program-personnel requirements and responsibilities-regulatory controls
7	Patient protection: Safe work practice in teletherapy and brachytherapy-quality assurance-equipment and accessories-treatment records.
8	Radiation emergencies: Situation preparedness, safety and prevention-legal requirements. Recent developments in radiation safety related topics.
9	Technical protective consideration during Radiography: Evaluation of hazards; Effective communication; Immobilization; Beam limiting devices; Filtration; Exposure

	factors; Protection in Fluoroscopy _ mammography_ mobile radiography_ CT Scan_ Angiography room.
10	Quality Control in Radiology: Quality control procedure in Radiology as per NABH.- Quality assurance in Radiology
11	Biological aspects of Radiological protection: Biological effects of radiation; Direct & Indirect actions of radiation; Concept of detriment – Deterministic & stochastic effect of radiation – somatic and genetic effects; Dose relationship; Effects of antenatal exposure.

RADIATION HAZARDS, PROTECTION AND CONTROL – RAD14303P

RADIOTHERAPY TECHNIQUES AND THEIR RECENT ADVANCEMENTS – RAD14304

UNIT	CONTENT
1	Equipment of Radiotherapy : Introduction, Principle and applications of Varian Trilogy Linear Accelerator with on board imaging (OBI), Medical Linear Accelerator, Electronic portal Imaging, 120 Multi leaf Collimator (MLC), Optical Guidance System, Respiratory gating, Radiation Therapy Cobalt
2	Tumor localization: Radiological diagnostic procedures – X-ray, ultrasound, CT scan MRI, Mammogram-Radio nuclide investigation; Tumor localization & check film and application of simulation in radiotherapy.
3	Treatment planning : CT planning-MRI planning-Interpretation of treatment prescription; Record keeping relevant to planning ; patient position, support, immobilization, Land marks; Mould room techniques and immobilization; Treatment positioning in radiotherapy to various cancers; CNS-benign-pituitary-craniophan; Malignant tumor-primary and secondary; orbit-eye –middle ear-parotid-buccal mucosa-tongue-hard palate-maxillary antrum- nasopharynx- oropharynx- hypo pharynx- larynx- oesophagus- media sternum-lung- bladder- prostate-penis- testis-cervix-,body of the uterus—vagina-vulva-lymphoma.
4	External beam therapy practical experience : Care of machine-Set up single, multiple fields-Use of wedges, shields and tissue compensators-Use of beam directional devices, methods of patient immobilization-Knowledge of technique involving electron beam

	therapy-moving beam therapy-conformal therapy-stereo tactic radio surgery and radiotherapy-Handling emergencies in Teletherapy
5	Mould room technique: Construction of casts-Construction of applicator and moulds-Construction of shields.
6	Brachytherapy: Principle of brachytherapy; interstitial-intracavitary-surface mould-intra luminal- Safe handling of small sealed radioactive sources. Preparation, - Storage Brachytherapy source-Check x-rays -Record keeping in relation to brachytherapy sources patient data.
7	Wedges tissue compensator: irregular field-SSD & SAD technique-oblique field-arc-rotational and moving field; Mantle field-irregular field-Hemi body irradiation-whole body irradiation-total body skin irradiation.
8	Special techniques in Radiation Therapy: Stereo tactic radiation Therapy (SRT) – Stereo tactic Radio surgery (SRS) –. Methods – BRW and CRW frames – angiographic localizer box – preparation of target sheets – Quality Assurance – Isocentric check – Treatment execution – care to be taken – check list.
9	Conformal Radiotherapy: Introduction to Conformal Radiotherapy, Importance, Applications and Principles of 3 D treatment.
10	Recent developments in radiotherapy and treatment Techniques: Intensity modulated radiation therapy (IMRT), Image guided radiation therapy (IGRT), Helical tomotherapy, and Volumetric modulated arc therapy, Stereotactic radiotherapy, Robotic radiotherapy, Challenges in the introduction of new technologies.

RADIOTHERAPY TECHNIQUES AND THEIR RECENT ADVANCEMENTS – RAD14304P

MEDICAL IMAGING INFORMATICS – RAD14305

UNIT	CONTENT
1	Basic Knowledge Management, Data Mining, and Text Mining: 15.1 Basic Knowledge Mapping, Database and Management; Data Mining, Machine Learning, and Data Analysis

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	Paradigms; Image Mining; Text Mining.
2	Ontological Concepts and Entity Relationships for Knowledge Creation and Discovery: Ontological Modeling; Medical Image Indexing and Vocabulary Systems; Medical Image Integrating Documents Structure; Unified Medical Language Systems; Medical Imaging Knowledge Creations, Linkages, and Discoveries to Medical Domains (Anatomy, Surgery, Neurology, etc.); Semantic Interoperability and Knowledge Exchanges.
3	Image Data Mining and Text Mining in Medical Imaging Informatics: Medical Image Database Systems; Medical Image Search Algorithms; Medical Image Mapping Algorithms; Medical Image Sorting Algorithms.
4	Advanced Medical Image Data Mining Algorithms and Solutions in Medical Imaging Informatics: Medical Image Data Mining Algorithms; Entropy in Medical Image Expressions; Statistical Approaches (Statistical Chains); Image Data Mining Tools.
5	Intelligent-knowledge based Decision-Making Mechanisms in Healthcare Information Systems: Decision Making Paradigm; Artificial Intelligence Application in Medical Imaging Informatics; Automata Computer-Aided Detection Systems for Cancer Diagnostics; Computer-Aided Planning for Cancer Treatments; Anatomic Knowledge and Medical Image Guided Medical Therapies.
6	Computational Medical Imaging Informatics: Parallel Computing Systems, Parallel Computing Architectures, Interconnection, and Message Passing; Parallel Algorithms for Medical Imaging; Technical Implementation on High Performance Computer; Multi-core Programming for Medical Imaging; Parallel Computing in Medical Image Data Management, Data Mining, and Knowledge-based Diagnostic and Treatment Systems.
7	Integration, Standards and Interoperability: Integration Challenges and General IT Standards; IT Standards Imaging and Internet Standards; DICOM Standards; HL7 Standards; Interoperability and IHE standards.
8	Medical Image Distribution, Networks and Communications: Network Architecture Topology and Protocols; Network Structure and System Components; Medical Image Data Transfers; Internet Services; Web Applications, Web Services, and Client/Server Distributed Computing; Enterprise Computing for Medical Imaging Informatics.
9	Open Architectures in Medical Imaging Informatics: Enterprise Radiology Information System Architecture (eRIS); Enterprise Health Care Information System (eHIS); PACS Generic Architecture; PACS Strategic Planning; Internet-based, Large-scale PACS System; Open Architecture Layers of Medical Image Informatics System; Medical Image Workflow and MII-Open System Architecture; Open Enterprise Radiology Information System Architecture (OeRIS); PACS-RIS-HIS Relationships; Global RIS, Teleradiography and Large-scale Healthcare Information System.

MEDICAL IMAGING INFORMATICS – RAD14305P

Hospital Training – TRN14301