

बी.पी. कोइराला मेमोरियल क्यान्सर अस्पताल
प्राविधिक (स्वास्थ्य) सेवा, मेडिकल (चिकित्सक) समुह, न्यक्लियर मेडिसिन उपसमुह, नबौ अधिकृत नबौ तह,
रजिष्ट्रार पदको खुला प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

यस पाठ्यक्रम योजनालाई दुई चरणमा विभाजन गरिएको छ :

प्रथम चरण :- लिखित परीक्षा (Written Examination)

पूर्णाङ्क :- २००

द्वितीय चरण :- अन्तर्वार्ता (Interview)

पूर्णाङ्क :- ३०

परीक्षा योजना (Examination Scheme)

प्रथम चरण (First Phase) : लिखित परीक्षा

Paper	Subject	Full Marks	Pass Marks	No. Questions & Weightage	Time Allowed
I	General Subject	100	40	10 × 5 = 50 (Short answer) 5 × 10 = 50 (Long answer)	3.00 hrs
II	Technical Subject	100	40	6 × 10 = 60 (Long answer) 2 × 20 = 40 (Problem Solving)	3.00 hrs

द्वितीय चरण (Second Phase)

Subject	Full Marks	Examination
Interview	30	Oral

द्रष्टव्य :

- यो परीक्षा योजनालाई प्रथम चरण (लिखित परीक्षा) र द्वितीय चरण (अन्तर्वार्ता) गरी दुई चरणमा विभाजन गरिएको छ ।
- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुवै हुनेछ ।
- प्रथम र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- परीक्षामा सोधिने प्रश्नसंख्या, अङ्क र अङ्कभार यथासम्भव सम्बन्धित पत्र/विषयमा तोकिए अनुसार हुनेछ ।
- विषयगत प्रश्नमा प्रत्येक खण्डका लागि छुट्टाछुट्टै उत्तरपुस्तिकाहरु हुनेछन् । परीक्षार्थीले प्रत्येक खण्डका प्रश्नहरुको उत्तर सोही खण्डका उत्तरपुस्तिकामा लेख्नुपर्नेछ ।
- यस पाठ्यक्रममा जे सुकै लेखिएको भएतापनि पाठ्यक्रममा परेका ऐन, नियमहरु, परीक्षाको मिति भन्दा ३ महिना अगाडी (संशोधन भएका वा संशोधित भई हटाईएका वा थप गरी संशोधित भई कायम रहेका) लाई यस पाठ्यक्रममा परेको सम्झनु पर्दछ ।
- प्रथम चरणको परीक्षाबाट छनौट भएका उम्मेदवारहरुलाई मात्र द्वितीय चरणको परीक्षामा सम्मिलित गराइनेछ ।
- पाठ्यक्रम लागू मिति :- २०७८/०२/२२

Paper I: General Subject

Section (A): 40% Marks (4×5 marks, 2×10 marks)

1. Administration and Management

- 1.1. Public Administration: concept, scope, functions and challenges
- 1.2. Management: concept, scope, functions, principles, and its practices
- 1.3. Contemporary management issues and challenges
- 1.4. Hospital Management : concept, scope, function, principle and its practices
- 1.5. Human resource management: concept, functions and different aspects
- 1.6. Basic managerial skills: coordination and public relation, communication and counselling, problem solving and decision making, leadership, team building, rapport building, planning, organizing, monitoring and evaluation
- 1.7. Emerging management concepts and their application in the Nepalese Public Management: Time management, Resource management (human, financial and physical), Technology management, Performance management, Stress management, Conflict management, Risk management and Participative management
- 1.8. Planning: concept, principles, nature, types, instrument and steps
- 1.9. Motivation, appreciative inquiry and social responsibility
- 1.10. Positive attitude and self-development
- 1.11. Group dynamic and organizational behavior
- 1.12. Grievance redressal and settlement
- 1.13. Financial Management: Concept, Approaches, Budget Formulation and Implementation, Auditing and topics related to Fiscal administration

Section (B): 40% Marks (4×5 marks, 2×10 marks)

2. General Health Issues

- 2.1. Present Constitution of Nepal (health and welfare issues)
- 2.2. National Health Policy
- 2.3. Health sector in current periodical plan
- 2.4. Health Service Act, 2053 and Health Service Regulation, 2055
- 2.5. Professional council related acts and regulations
- 2.6. Act Regulating Narcotics
- 2.7. NMC and National Health Agencies
- 2.8. Indigenous and traditional faith healing and health practices
- 2.9. International health agencies: Role and responsibilities of WHO, UNICEF, UNFPA and interagency relationships
- 2.10. Health and Human Right including Women's Right, Children's Right, Professional's Right, Client Right and Informed consent
- 2.11. Gender issues and health
- 2.12. Urbanization and health impacts
- 2.13. National health training system
- 2.14. Supervision, types and its usage in Health Sector
- 2.15. Monitoring and Evaluation System in Health

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- 2.16. Health Management Information System
- 2.17. Health economics - basic terms, health insurance and financing in Health Care
- 2.18. Federal governance and decentralization in health
- 2.19. Evidence Based Medicine / Critical Appraisal of Scientific Literature
- 2.20. Principles of Research Methodology and Scientific paper writing/publication
- 2.21. Professional and medical ethics
- 2.22. Informed Consent and Medico legal Issues
- 2.23. Medical Audit and Quality Assurance
- 2.24. Information technology and Tele medicine
- 2.25. Drug act and regulation
- 2.26. Rational use of drugs, national drug policy and importance of essential drug list
- 2.27. Ethics, Integrity and Accountability of health professionals
- 2.28. Private sector health institution its regulation and management
- 2.29. Health institution development and management
- 2.30. Patient safety & Breaking Bad News
- 2.31. Cancer Registry: Hospital and Community Based Cancer Registry
- 2.32. Preventive Oncology
 - 2.32.1. Epidemiology
 - 2.32.2. Primary prevention (Cancer Awareness, Cancer Education, Vaccination)
 - 2.32.3. Secondary Prevention (Screening, Screening Methods)
- 2.33. Multidisciplinary Approach in Cancer Management

Section (C): 20% Marks (2×5 marks, 1×10 marks)

3. Organizational Knowledge

- 3.1. B.P.Koirala Memorial Cancer Hospital : History, organizational structure, functions, roles, services, possibilities, problems and challenges
- 3.2. Service provided by B.P.Koirala Memorial Cancer Hospital-service types, quality, technology, citizen engagement in service design
- 3.3. Relations between Government and other national and international related organizations
- 3.4. Health manpower recruitment and development in B.P.Koirala Memorial Cancer Hospital
- 3.5. B.P.Koirala Memorial Cancer Hospital related act and regulations

Paper II : Technical Subject

Section (A) – 50 % Marks

1. **Basic Mathematics and Medical Statistics for Nuclear Medicine**
 - 1.1 Logarithmic & exponential functions
 - 1.2 Differentiation & integration
 - 1.3 Simple first & second order differential equations & their solutions
 - 1.4 Compartmental analysis
 - 1.5 Population-sample - kinds of samples - types of measurements or data
 - 1.6 Mean-Median-Mode-Standard Deviation- Coefficient of variation-percentage error - standard error of Mean (SEM)
 - 1.7 Binomial, Poisson & Gaussian distribution, Estimations & confidence limits, testing hypothesis - Null hypothesis & significance tests (students test, Chi square)
 - 1.8 Analysis of variation & co-variation, correlation coefficient by curve fitting method of least square fit.
 - 1.9 Computer methods of analyzing medical data
2. **Fundamentals of Electricity & Electronics**
 - 2.1 Electrical conductivity, charge, voltage, current, resistance, Coulomb's law, Ohm's law, D.C. & A.C.
 - 2.2 Components of electronic circuits, active & passive elements: their function & applications
 - 2.3 Basic electronic circuits: power supply, amplifiers, oscillators, pulse shapers
 - 2.4 Introduction to digital electronics: ADC, DAC, logic units, integrated, circuits, microprocessors
3. **Basic principles of Immunology**
 - 3.1 Introduction : Antigen – antibody reaction – basis of specificity
 - 3.2 Immunoglobulins : Structure of immunoglobulins – variations in structure of immunoglobulins – comparison of immunoglobulin classes
 - 3.3 Synthesis of antibody:
 - 3.3.1 Types of immune response
 - 3.3.2 Role of lymphocytes & details about the immune response & functions – Two populations of Lymphocytes : T & B – cells
 - 3.3.3 Cellular co-operation in the immune response synthesis of humoral antibody
 - 3.3.4 Immunological tolerance
 - 3.3.5 Theories of antibody synthesis
 - 3.4 "In vitro" Immune reactions
 - 3.5 Precipitation – Antigen binding techniques – Immunofluorescence
 - 3.6 Reactions with cell surface antigens complement – Neutralization of biological activity – Lymphocyte stimulation – Leucocyte migration inhibition test
 - 3.7 Hypersensitivity: Types of hypersensitive reactions, Autoimmunity
4. **Basic principles of chemical reactions**
 - 4.1 Fundamental concepts, oxidation, reduction, acids, bases, hydrogen, Ion concentration, dissociation constants, pH value, Ionic equilibria, buffer solutions
 - 4.2 Fundamental concepts of organic chemistry, hydrocarbons, aliphatic hydroxyl compounds, non aliphatic hydroxy compounds, aldehydes, ketones, carboxylic acids, esters amines, amides hydrogen derivatives

- 4.3 Chemical bonds – electrovalent bond, covalent bond & co-ordinate covalent bond;
Chelate compounds

5. Radiation Biology

- 5.1 Brief overview of interactions of ionizing radiation with matter
- 5.2 Sources of Radiation
- 5.2.1 Environmental - Natural, Artificial
- 5.2.2 Medical
- 5.2.3 Occupational
- 5.3 Measurement of Radiation and its Effects
- 5.3.1 Exposure
- 5.3.2 Absorbed dose
- 5.3.3 Dose equivalent
- 5.4 Cell Biology
- 5.4.1 Cell structure, Molecular components, Cell reproduction
- DNA synthesis
 - Mitosis
 - Meiosis
- 5.4.2 Cell replication cycle
- 5.4.3 Chemical effects of radiation
- 5.4.4 Radiation effects on Macromolecules
- 5.4.5 Cell survival curves
- 5.4.6 LD 50 effects
- 5.4.7 Concepts of Clinical radiation pathology
- 5.4.8 Relative biological effectiveness (RBE)
- 5.4.9 Free radicals
- 5.4.10 Target theory
- 5.4.11 Radiation Genetics
- Causes and effects of genetic mutations - Spontaneous mutation, Mutagenesis, Carcinogenesis, Gene mutations and cancer
 - Effects of radiation on DNA
 - Chromosome and chromatid aberrations
 - Repair versus mutation
- 5.5 Cellular Responses to Radiation
- 5.5.1 Stage of cell replication cycle versus radiosensitivity
- 5.5.2 Factors Affecting Cellular Response to Radiation, RBE and LD50/30, Physical factors, Chemical factors, Biological factors
- 5.6 Radiosensitivity and Cell Populations, Law of Bergonie and Tribondeau
- 5.7 Tissue and Systemic Responses to Radiation
- 5.7.1 Acute versus late effects
- 5.7.2 Healing of irradiated tissue
- 5.7.3 Total-body irradiation - Sources of information, Hematopoietic syndrome, Gastrointestinal syndrome, Central nervous system syndrome, Cardiac shock syndrome
- Radiosensitivity of embryo/fetus
 - Phases of embryonic/fetal development
 - Effects of radiation versus phase of development
- 5.8 Late Effects of Radiation Exposure
- 5.8.1 Relating radiation exposure to specific effects
- Dose versus effect models

- Problems associated with researching radiation-induced effects/disease
- 5.8.2 Non-specific life-shortening
 - Genetic effects (spontaneous mutation versus radiation induced damage)
 - Carcinogenesis, Cataract instigation, Other diseases
- 5.9 Radiation doses
 - 5.9.1 Factors influencing absorbed dose from internal sources
 - Concentration and organ mass
 - Effective half-life
 - Physical and chemical characteristics of radionuclide
 - Absorbed fraction
 - Cross-irradiation
 - 5.9.2 Critical and target organs
 - Target organs
 - Non-target critical organs
 - Gonadal exposure
 - 5.9.3 Absorbed dose calculations
 - Classical and MIRD methods
 - Formulas
 - Charts and tables
- 5.10 Risk-to-Benefit Ratios
 - 5.10.1 Radiation hazard versus medical need
 - 5.10.2 Diagnostic exposures
 - Exposure from various sources (x-ray, computed tomography)
 - Radiation levels in nuclear medicine
 - 5.10.3 Therapeutic exposures
 - Exposure from various sources (radiation therapy, implants)
 - Radiation levels in nuclear medicine
- 6. **Nuclear Physics**
 - 6.1 Structure of atom : Different models of atom, Physical & chemical properties. Avogadro's Number, Periodic table, isotopes, isobars & isotones.
 - 6.2 Radioactivity : Nuclear forces, nature & origin of radioactivity, types of radiations, nuclear transitions, units of radioactivity, physical properties of radioactivity, radioactive decay, decay schemes, trilinear radionuclide chart, physical half life, decay constant, average life, biological & effective half life, radionuclides in equilibrium, natural & artificial radioactivity.
 - 6.3 Production of radioisotopes: Fission process, nuclear reactions, nuclear reactors, accelerators, medical cyclotrons, nature & properties of artificially produced radioisotopes.
 - 6.4 Interaction of radiation with matter :
 - 6.5 Interaction of alpha & beta particles with matter, scatter, ionization, bremhstrahlung, cerenkov, annihilation reactions.
 - 6.6 Interaction of gamma radiation with matter : scatter, photoelectric effect, pair production
 - 6.7 Penetration of radiation in matter, half value thickness, absorption coefficient, absorption cross section curves with respect to gamma energy & atomic number. Range of radiations in tissue, lead & NaI (T1)
- 7. **Radiation Detection & Measurement**
 - 7.1 Radiation detectors (gas) : Ionization chamber, proportional counters, GM counter – principles, operation & use in nuclear medicine

- 7.2 Scintillation detectors (solid) : NaI (T1), CsI, BGO, LSO crystals, photomultiplier tube
 - 7.3 Scintillation detectors (Liquid): Liquid organic scintillators sample preparation, quenching & its correction.
 - 7.4 Semiconductor detectors : Principle, properties & use
 - 7.5 Gamma ray spectrometer : Principle, operation & use
 - 7.6 Measurement of radioactivity: Principles, counting geometry, efficiency of detection in in-vitro 'in-vivo' counting
 - 7.7 Counting statistics : Standard deviation (SD), percent error measurement of SD of addition, subtraction, multiplication & division of two countrates
8. **Health Physics**
- 8.1 Units & definitions: Radiation, exposure, absorbed dose in air & in man, SI units.
 - 8.2 Radiation Exposure : Natural radioactivity in man, exposure from natural & artificial sources, concept of maximum permissible level, ICRP regulations, exposures in pregnancy, in children & in radiation laboratories.
 - 8.3 Radiation protection : Evaluation of radiation hazards, protection measures, shielding personal & area monitoring, internal radiation hazards, control of contamination waste disposal, permissible levels, techniques of licensing.
 - 8.4 Radiation Measuring instruments : GM counters, contamination monitors, exposure monitors – film badge, TLD, gun monitors, dosimeters. Dose calibrators & quality control of dose calibrators.
 - 8.5 Internal radiation dosimetry : Estimation of radiation dose delivered to various body organs & total body by internally administered radionuclides for diagnostic & therapeutic purposes by MIRD methods.

Section (B) – 50 % Marks

9. **Nuclear Medicine Instruments & Maintenance**
- 9.1 Block diagram & understanding of specifications of the electronic instruments used in nuclear medicine laboratory, power supply, voltage regulators, count rate meter, oscilloscope display, video display, chart recorder, printers.
 - 9.2 General care & maintenance of the electronic equipment in nuclear medicine laboratory
10. **Scintigraphy (Instrumentation)**
- 10.1 Rectilinear scanners : Instrument & principle of working, collimators & their evaluation, technique of scanning on a scanner, limitations & pitfalls concept of information density in imaging, various types of scanners.
 - 10.2 Scintillation cameras : Description of instrument and principle of working collimators & their evaluation, technique of organ imaging on a scintillation camera, limitations & pitfalls, how to choose a scintillation camera.
 - 10.3 Other imaging devices (emission type) : Positron emission tomography system, Freshnel zone plate camera, semiconductor camera, multiwire proportional counter camera.
 - 10.4 Tomography: Concept of tomography in imaging, emission tomographic cameras
 - 10.5 Photographic processes : Display systems in nuclear medicine imaging, hard copy records, concepts of exposure & developing of a transparency film, preparation of dark room & developing solutions, film characteristics and its importance in imaging.
 - 10.6 Quality assurance & quality control of nuclear medicine imaging instruments scanners & scintillation cameras: methods of quality control, guidelines for daily & periodic tests

11. Other imaging modalities

- 11.1 Computerised Tomography
- 11.2 Ultrasonic imaging
- 11.3 NM R Imaging

12. Clinical Scintigraphy

- 12.1 Elements of anatomy & physiology of different body organs considered in scintigraphy & other nuclear medicine investigations
- 12.2 Radiopharmaceuticals used for imaging the organ & merits or demerits if any
- 12.3 Methods of localization of radiopharmaceuticals
- 12.4 Difference in SPECT & PET techniques, advantages , disadvantages
- 12.5 Use of SPECT CT & PET CT
- 12.6 PET MR imaging
- 12.7 Normal scan appearances in planar, SPECT & PET – normal physiological & anatomical variations
- 12.8 Artifacts in scan interpretations
- 12.9 Abnormal scans with respect to clinical diagnostics
- 12.10 Procedures of all planar, SPECT & PET scans
- 12.11 Indications & usefulness of scan with respect to clinical diagnosis
- 12.12 Limitations of information obtained by scans
- 12.13 Newer modalities of imaging like ultrasound, CT, NMR & comparison with nuclear medicine techniques.

13. Dynamic Studies in Nuclear Medicine

- 13.1 Instrumentation: Clinical analyzer, computers description & principle of working of the computer. Technique of performing dynamic studies with computer, Limitations & pitfalls
- 13.2 Nuclear Cardiology : Radiopharmaceuticals, first pass & multigated equilibrium studies, determination of cardiac shunts, ejection fractions at rest & in stress, coronary blood flow studies – wall motion studies, newer developments in nuclear cardiology techniques,. Clinical evaluation of the nuclear cardiology techniques, its merits
- 13.3 Renal studies : Radiopharmaceuticals, measurement of renal blood flow, glomerular filtration rate, renal clearance & rejection of grafting in renal transplant by radionuclide renal studies, merits & demerits.
- 13.4 Dynamic studies using PET RP: Cerebral & cardiac reserve.

14. Radiopharmaceuticals

- 14.1 General principles of tracer techniques
- 14.2 Production of Radionuclides – SPECT & PET
- 14.3 Reactor & its principle
- 14.4 Production of radionuclides in reactor
- 14.5 Cyclotron & its principle
- 14.6 Different generator systems
- 14.7 Production of radionuclides in cyclotron
- 14.8 Linear accelerator
- 14.9 Betatron
- 14.10 Choice of radionuclides
- 14.11 Primary radionuclides – labeled compounds, Iodination, labeling with other radionuclides

- 14.12 Therapeutic radionuclides
 - 14.13 Purity of radiopharmaceuticals
 - 14.14 Chemical purity, Radiochemical purity, Radionuclide purity, Biological purity
 - 14.15 Stability of radiopharmaceuticals, parameters which affect stability
 - 14.16 Quality control of radiopharmaceuticals
 - 14.17 Radiochemical & chemical purity – methods used to determine
 - 14.18 Radionuclidic purity – methods used
 - 14.19 Sterility testing – methods used
 - 14.20 Pyrogen testing – methods used
 - 14.21 Various types of radionuclides generators
 - 14.22 ^{99}Mo - $^{99\text{m}}\text{Tc}$ generator & preparation of different labeled compounds with Tc 99m
 - 14.23 ^{113}Sn - $^{113\text{m}}\text{In}$ generator & preparation of different labeled compounds
 - 14.24 ^{68}Ge – ^{68}Ga generator & preparation of different labeled compounds
 - 14.25 Other generators of interest in Nuclear Medicine
 - 14.26 Mechanism of localization of radiopharmaceuticals – modern trends in radiopharmaceuticals
 - 14.27 Handling of radiopharmaceuticals
 - 14.28 Safety measures, equipments, shields, remote handling
 - 14.29 Dose preparation, packaging, storage, waste disposal
 - 14.30 Economic aspects of radiopharmaceuticals
 - 14.31 Legal aspects of radiopharmaceuticals
- 15. Therapeutic Applications of Radionuclides**
- 15.1 Treatment of hyperthyroidism with radioiodine,
 - 15.2 Treatment of thyroid cancer,
 - 15.3 Bone pain palliation
 - 15.4 Therapy for polycythaemia vera
 - 15.5 Radiosynovectomy
 - 15.6 Monoclonal antibodies treatment
 - 15.7 Other modes of internally administered isotopes for therapy
- 16. Thyroid Function Studies**
- 16.1 Physiology of thyroid gland – Iodine metabolism in man
 - 16.2 In vivo thyroid function tests: Thyroid uptake, PB 131 T, T3 suppression, TSH stimulation, perchlorate discharge test, Techniques of performing these tests, their limitations.
 - 16.3 In vivo thyroid function tests : PB I, T3 –charcoal ratio, T3 – RBC uptake, competitive protein binding assays for T3, T4, free T4 & FTR, merits & demerits, factors affecting these tests.
- 17. Absorption Studies**
- 17.1 Whole body counters: Instrument description, principle of working & technique of whole body counting, different types of whole body counters, their merits & demerits.
 - 17.2 Basic principles of absorption studies, factors affecting absorption, clinical evaluation of these studies B-12 absorption studies, shielding test, double tracer technique, iron absorption, folic acid absorption, T3-T4 absorption – Dual marker technique
- 18. Haematological uses of radioisotopes**

- 18.1 Blood volume, RBC volume, plasma volume, RBC survival
- 18.2 In vitro techniques :
 - 18.2.1 Tracer kinetics: Principle of single compartment – multi compartment basic equations
 - 18.2.2 Body fluids & electrolytes : turnover of total body sodium, potassium; Total body water – Body composition of various electrolytes.
 - 18.2.3 Erythrokinetics – Iron kinetics, clinical usefulness, medullary & extra medullary erythropoiesis
 - 18.2.4 Protein turnover studies – synthesis & catabolism – use of radioactive tracers in albumin turnover
 - 18.2.5 Radiorespirometry : Glucose, palmitic acid & carbohydrate metabolism use of technique for bacterial contamination, drug sensitivity
 - 18.2.6 Neutron activation analysis – detection of tracer elements in biological samples
 - 18.2.7 Autoradiography
 - 18.2.8 Biochemical applications of tracers : Carbohydrate (Chemistry, metabolism); Lipids ((Chemistry, metabolism); Proteins (Chemistry, metabolism); Nucleic acids; Vitamins, Minerals & Enzymes

19. Radioimmunoassays

- 19.1 Principles of RIA
- 19.2 General considerations in the preparation of iodine labeled tracers
- 19.3 Selection of suitable radioisotope, Radioactive labeling of proteins
- 19.4 Mechanism of Iodination & structure of Iodinated compounds.
- 19.5 Methods of iodination, Specific activity & substitution levels.
- 19.6 Iodination damage & quality control of iodinated tracers.
- 19.7 Stability of iodinated tracers.
- 19.8 Radioiodination & safety measures
- 19.9 Definition of antibodies, their function & mode of preparation.
- 19.10 Specificity of antibodies. Properties of antibodies. Affinity & binding capacity. Quality control of antibodies. Other variants of binding substances. Assay procedure & optimization of assay procedures. Separation methods of bound and free fractions. Data processing & computations.
- 19.11 Quality control measures in RIA's.
- 19.12 Receptor assays: Receptors, their physiological role mechanism of action & utility inn clinical diagnosis.
- 19.13 Enzyme immunoassay – Principles & applications in clinical diagnosis
- 19.14 Administrative aspects of Nuclear Medicine :
 - Planning of radioisotope laboratory: Basic considerations, layout, equipment, classification of Nuclear Medicine laboratory, staff, clearance of premises, licensing for use of radionuclides in humans
 - Cost benefit & efficacy of Nuclear Medicine investigations, role of Nuclear Medicine in diagnostic decision making, professional ethics
 - Layout & commissioning of High dose RN Therapy wards
 - Layout & commissioning of PET CT