

वि.पि. कोइराला मेमोरियल क्यान्सर अस्पताल
प्राविधिक (स्वास्थ्य) सेवा, मेडिकल (चिकित्सक) समुह, रेडियसन अंकोलोजी उपसमुह, जुनियर कन्सल्टेण्ट पदको
खुला र आन्तरिक प्रतियोगितात्मक परीक्षाको पाठ्यक्रम एवं परीक्षा योजना

कूल पूर्णाङ्क :- १५०

१. प्रथम चरण : - लिखित परीक्षा						पूर्णाङ्क :- १००	
पत्र	विषय	पूर्णाङ्क	उतीर्णाङ्क	परीक्षा प्रणाली		प्रश्नसंख्या X अङ्क	समय
प्रथम	प्राविधिक विषय र सम्बन्धित कानूनहरु	१००	४०	वस्तुगत	बहुवैकल्पिक प्रश्न	१०० प्रश्न x १ अङ्क	१ घण्टा ३० मिनेट
२. द्वितीय चरण : - प्रयोगात्मक							
विषय	पूर्णाङ्क	उतीर्णाङ्क	परीक्षा प्रणाली			समय	
प्रयोगात्मक	३०	-	प्रयोगात्मक				
३. तृतीय चरण : - अन्तर्वार्ता							
विषय	पूर्णाङ्क	उतीर्णाङ्क	परीक्षा प्रणाली			समय	
अन्तर्वार्ता	२०	-	मौखिक				

द्रष्टव्य :

- यो परीक्षा योजनालाई प्रथम चरण (लिखित परीक्षा), द्वितीय चरण (प्रयोगात्मक) र तृतीय चरण गरी तीन चरणमा विभाजन गरिएको छ ।
- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुवै हुनेछ ।
- लिखित परीक्षामा यथासम्भव पाठ्यक्रमका सबै एकाईबाट प्रश्नहरु सोधिनेछ ।
- विषयगत प्रश्नमा प्रत्येकपत्र/विषयका प्रत्येक खण्डका लागि छुट्टाछुट्टै उत्तरपुस्तिकाहरु हुनेछन् । परिक्षार्थीले प्रत्येक खण्डका प्रश्नहरुको उत्तर सोही खण्डका उत्तरपुस्तिकामा लेख्नुपर्नेछ ।
- यस पाठ्यक्रम योजना अन्तर्गतका पत्र/विषयका विषयवस्तुमा जेसुकै लेखिएको भएतापनि पाठ्यक्रममा परेका कानून, ऐन, नियम तथा नीतिहरु परीक्षाको मिति भन्दा ३ महिना अगाडि (संशोधन भएका वा संशोधन भई हटाईएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झनु पर्दछ ।
- प्रथम चरणको परीक्षाबाट छनौट भएका उम्मेदवारहरुलाई मात्र दोस्रो चरणको परीक्षामा सम्मिलित गराईनेछ । दोस्रा चरणको परीक्षाबाट छनौट भएका उम्मेदवारहरुलाई मात्र तृतीय चरणको परीक्षामा सम्मिलित गराइनेछ ।
- वस्तुगत बहुवैकल्पिक (Multiple Choice) प्रश्नहरुको गलत उत्तर दिएमा अङ्क कट्टा गरिने छैन ।
- पाठ्यक्रम लागू मिति :- २०७३/४/३०

यस पत्र/विषयको पाठ्यक्रमबाट यथासम्भव निम्नानुसार प्रश्नहरु सोधिनेछ ।

खण्ड	अङ्कभार	प्रश्न संख्या
		वस्तुगत
A	९०	९० प्रश्न X १ अङ्क = ९०
B	१०	१० प्रश्न X १ अङ्क = १०

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Section (A) – 10 Marks

1. B.P.Koirala Memorial Cancer Hospital, Related Legislations and General Health Issues

- 1.1. B.P.Koirala Memorial Cancer Hospital : History, organizational structure, functions, roles, services, problems and challenges
- 1.2. National Health Policy
- 1.3. B.P.Koirala Memorial Cancer Hospital related act and regulations
- 1.4. Health Service Act, 2053 and Health Service Regulation, 2055
- 1.5. Professional council related acts and regulations
- 1.6. NMC and National Health Agencies
- 1.7. Preventive Oncology
 - 1.7.1. Epidemiology
 - 1.7.2. Primary prevention (Cancer Awareness, Cancer Education, Vaccination)
 - 1.7.3. Secondary Prevention (Screening, Screening Methods)
- 1.8. Structure and Organization of Oncology Services in Nepal and Developed Countries

Technical Subject

Section (B) – 90Marks

1. Radiation Physics

- 1.1 **Atom and Particles:** Definition; structures-nucleus, orbital shells, energy levels, binding energy; atomic number, atomic weight, isotope, isomer, isobar, proton, neutron, electron and positron
- 1.2 **Photon Interaction:** Coherent scattering, photoelectric effect, Compton scattering, pair production, annihilation radiation and photonuclear reactions
- 1.3 **Electron Interactions:** Ionisation, excitation, heat production; radioactive interaction (bremsstrahlung), relative rate of energy loss and directional changes through collisional and radioactive processes; stopping power, range, scattering power, linear energy transfer
- 1.4 X-ray and basic principles of X-ray production
- 1.5 **External Photon Beam Radiation Therapy**
 - 1.5.1 Radiotherapy machines (Betatron, Van De Graff generator, Cobalt, Linear accelerator): constructions and process of photon production
 - 1.5.2 Alteration of the beam aperture using Cerrobend blocking, multileaf collimators and independent jaws
 - 1.5.3 Design and function of multileaf collimators including awareness of issues created by rounded leaf edges
 - 1.5.4 Types of wedge filters
 - 1.5.5 Characteristics of kV and MV photon beams:
 - 1.5.6 Measurements of an external photon beam, including choice of suitable radiation detector:
 - 1.5.6.1 Beam measurement: radiation quality, output & inverse square law
 - 1.5.6.2 Dose distribution - kV and MV beam profiles, depth dose curves, construction of isodose charts
 - 1.5.7 Dose distribution in tissue produced by external beam photon radiation:
 - 1.5.7.1 Radiation components i.e. primary and scattered radiation
 - 1.5.7.2 Descriptors of dose distribution: percentage depth dose, beam profile, isodose charts, flatness and symmetry, penumbra, surface dose and skin sparing.
 - 1.5.7.3 Factors affecting dose distribution and beam output: effects of field size and shape, source-skin distance, beam quality or energy and beam modifying devices on dose distribution and beam output
 - 1.5.7.4 Effects of tissue heterogeneity and patient irregularity: effects on dose distribution of patient contour, bone, lung, air cavities and prostheses; dose within bone cavities, interface effects.
 - 1.5.7.5 Effects on dose distribution of irregular or offset fields and associated clinical implications of changes in beam aperture: use of Cerrobend blocking, multileaf collimators and independent jaws
 - 1.5.7.6 Dose modification techniques: methods of compensation for patient contour variation and/or tissue inhomogeneity including

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wedging and compensating filters; shielding of dose-limiting tissues; the use of bolus and build-up material

1.5.7.7 Physical aspects of the treatment techniques: Fixed SSD and isocentric techniques; Simple techniques: parallel opposed fields, multiple fields; Complex techniques: rotation therapy (full or partial), conformal therapy, IMRT, VMAT, IGRT

1.6 Electron Beam Radiation Therapy

1.6.1 Process of generation of electron beam from a linear accelerator

1.6.2 Characteristics of an electron beam – energy spectra, energy specification, variation of mean energy with depth, photon contamination

1.6.3 Dose distribution in tissue from an electron beam:

1.6.3.1 Percentage depth dose, beam profiles, isodose charts, flatness and symmetry, penumbra, surface dose

1.6.3.2 Effects of field size and shape, source-skin distance, energy, beam collimation on dose distribution and beam output

1.6.3.3 Effects of heterogeneity and patient irregularity i.e. effect on dose distribution of surface obliquity, air gaps, lung, bone, air filled cavities, external and internal shielding

1.6.3.4 Methods of field shaping for different beam energies and effect on surface dose

1.7 Treatment Planning and Delivery for Photon and Electron Beams

1.7.1 Different equipment and methods for patient simulation; Processes of 2D and 3D planning; principles of intensity modulated radiation therapy and inverse treatment planning

1.7.2 Methods of determining body contour, location of internal structures including critical tissues and target volume including comparison of CT, MRI and PET

1.7.3 Choice of beam energy, field size, beam arrangement and the use of bolus

1.7.4 Use of field junctions in terms of: Photon-photon junctions, Photon-electron junctions, Electron-electron junctions

1.7.5 Accuracy of treatment planning and delivery:

1.7.5.1 Methods of patient monitoring and ensuring reproducibility of patient positioning throughout treatment and planning

1.7.5.2 Image-guided radiation therapy

1.7.5.3 Determination of mechanical and radiation accuracy of treatment machines and simulators

1.7.5.4 Systematic and random errors

1.7.5.5 Avoidance and detection of dose delivery errors

1.7.5.6 Potential errors arising from computer control of set up and treatment machine operation

1.8 Radiation Measurement Devices

1.8.1 Ionisation chambers, semi-conductor detectors and optically stimulated luminescence dosimeters (TLD and OSL)

1.8.2 Photographic film, radiochromic film, Geiger-Muller counters, scintillation counters, chemical dosimeters

1.8.3 Use of radiation phantoms and dedicated dosimetry tools for fixed SSD and isocentric patient treatments

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- 1.8.4 Radionuclides: caesium-137, iridium-192, iodine-125, palladium-106, strontium-90, radium-226, cobalt-60, yttrium-90
- 1.8.5 Management: handling, cleaning, inspection, storage and transport
- 1.8.6 Sealed source brachytherapy:
 - 1.8.6.1 Types of procedures - surface applications, eye plaques, interstitial implants, intracavitary techniques
 - 1.8.6.2 Source dose rate and dose distributions
 - 1.8.6.3 Delivery techniques: remote afterloading machines, manual afterloading
 - 1.8.6.4 ICRU dose specification system: current ICRU recommendations for interstitial and gynecological treatment specifications
- 1.9 **Unsealed Source Radionuclides**
 - 1.9.1 Physical, biological and effective half life
 - 1.9.2 Management: safe handling, storage, transport, clean up of spills
- 1.10 **Radiation Protection**
 - 1.10.1 ALARA principle, radiation incident and radiation accident
 - 1.10.2 International Commission on Radiation Protection(ICRP)recommendations and national radiation protection standards
 - 1.10.3 Medical exposure in contrast to exposure of the public and occupational exposure (justification, optimization and dose limits)
 - 1.10.4 Minimization of dose to patients, staff and general public including safety procedures for staff, control of areas and radiation sources, personal monitoring, area monitoring, construction of rooms to house sources and radiation generators
 - 1.10.5 Recommended dose limits for fetal exposure and human data from which these have been derived
 - 1.10.6 Documentation and reporting requirements relating to radiation incidents and accidents
- 2. **Radiation Biology**
 - 2.1 Law of Bergonie and Tribondeau
 - 2.2 Evolution of fractionated treatment :The ram's testis experiment, evolution of standard fractionation schedules, treatment protraction and adverse effects of protraction
 - 2.3 Cell: Normal cell structure; structure of eukaryotic genes e.g. open reading frame, untranslated regions, introns, exons, regulatory elements; chromosome packaging; DNA replication and the importance of maintaining genomic integrity; RNA transcription and translation; epigenetic effects on gene expression
 - 2.4 Cell Cycle: Phases and functions; Check points and their molecular controls; Major cell cycle regulators e.g. pRB, p53, cyclins, cyclin-dependent kinases; Cell cycle kinetic parameters; Extra cellular agents affecting cell growth e.g. growth factors, hormones; Growth factor receptors; Signal transduction e.g. MAPK/ERK, RAS, RAF pathways
 - 2.5 Mechanism of malignant cell transformation and progression
 - 2.5.1 Activation of oncogenes/loss of tumor suppressor genes: Mechanisms including point mutations, insertions, deletions, translocations, and amplifications; stable and unstable aberrations; Methods of quantification including comparative genomic and in-situ hybridization, spectral karyotyping

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- 2.5.2 Knudson's 2-hit hypothesis
- 2.5.3 Tumor angiogenesis and vasculogenesis
- 2.6 Tumor Growth: Gompertzian growth of untreated cancers including the concepts of tumour doubling time and potential doubling time; determinants of tumour growth rate including cell cycle time, growth fraction, cell loss factor; effect of tumour microenvironment on growth rate
- 2.7 Radiation Induced Cellular Damage
 - 2.7.1 Evidence for DNA being the clinically relevant target for cell killing and other targets of radiation damage
 - 2.7.2 Types of DNA lesions caused by ionizing radiation including double strand breaks (DSB), single strand breaks (SSB), cross links and base damage
 - 2.7.3 DNA damage repair mechanisms including sub-lethal damage and potentially lethal damage
 - 2.7.4 Radiation sensitivity in different phases of the cell cycle
 - 2.7.5 Modes of cell death including timing of cell death and relative importance following ionizing radiation including: mitotic catastrophe, apoptosis, radiation-induced senescence, necrotic death, autophagy
- 2.8 DNA double strand break repair
 - 2.8.1 Sensing DNA DSB
 - 2.8.2 Cell cycle arrest
 - 2.8.3 Histone modifications
 - 2.8.4 Recruitment of DNA DSB repair proteins
 - 2.8.5 DNA DSB repair pathway
 - 2.8.6 Homologous recombination and Non-homologous end-joining
 - 2.8.7 The genetic diseases that affect DNA repair/ clinically apparent radio-sensitivity (e.g. ataxia telangectasia)
- 2.9 Quantification of cell survival following irradiation
 - 2.9.1 Concept of cell survival curves
 - 2.9.2 In-vitro and in-vivo techniques to generate survival curves
 - 2.9.3 Dose rate effects on cell survival
 - 2.9.4 The linear quadratic formula in terms of: The biophysical basis of α and β in the linear quadratic formula, clinically derived α/β ratios for different types of cancer, acute and late responding normal tissues; limitations of linear quadratic formula
 - 2.9.5 Relationship between dose/fraction and tissue α/β ratio
- 2.10 Fractionations and "Rs" of radiobiology
 - 2.10.1 Conventional, hyper, hypo and accelerated fractionation
 - 2.10.2 Intrinsic Radiosensitivity, Repair, Reoxygenation, Redistribution, Repopulation
- 2.11 Biological Effective Dose
- 2.12 Hypoxia and the Oxygen effect
 - 2.12.1 Modification of radiation induced DNA damage by oxygen
 - 2.12.2 Oxygen enhancement ration (OER)
 - 2.12.3 Tumor hypoxia: clinical significance
 - 2.12.4 Methods used to overcome the effect of tumour hypoxia including their rationale: e.g. fractionation, hypoxic cell sensitizers, hypoxic cell cytotoxins, hyperbaric oxygen, high LET radiation, and hyperthermia

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- 2.12.5 Consequences of molecular responses to hypoxia including: angiogenesis, increased propensity for metastasis and genetic instability
- 2.13 Radiation quality
 - 2.13.1 Types of ionizing radiation; Linear Energy Transfer (LET) and its relationship to direct and indirect DNA damage, free radicals and free radical scavengers
- 2.14 Dose response
 - 2.14.1 Dose response curve: shape, determinants of steepness of curve
 - 2.14.2 Therapeutic ratio: concept and significance
 - 2.14.3 Radiocurability and radioresponsiveness
 - 2.14.4 Factors influencing tumor control: physical factors including dose, dose rate, radiation quality, temperature; chemical factors including oxygen, radio-sensitizers and radio-protectors; biological Factors including cell type and radiosensitivity, clonogen number, host factors; technical Factors including geographic miss; tumour control probability curves
- 2.15 Effects of radiation on normal tissues: Acute, sub-acute and late toxicity from radiation; meaning of latency with regard to normal tissue effects; functional sub-units of tissues/organs; flexible and hierarchical kinetic models; abscopal effect; post radiation regeneration of normal tissues; concept of normal tissue/organ tolerance; mechanism of effect and consequences of radiation on: parenchymal tissues, connective tissues, vascular systems and immune system
- 2.16 Acute syndromes following high doses of total body radiation
 - 2.16.1 Acute radiation syndrome: prodromal period, latent period, critical phase (manifestation of disease) and recovery or death
 - 2.16.2 Cerebrovascular syndrome
 - 2.16.3 Hematological syndrome
 - 2.16.4 Gastrointestinal syndrome
- 2.17 Effects of radiation on human embryo and fetus
 - 2.17.1 Major phases of fetal development, including CNS growth and corresponding gestational age; Nature of and reasons for effects caused in utero; Factors influencing effect type and risk including dose and stage of gestation; Definition of doubling dose
- 2.18 Quantification of radiation effects on normal tissues
 - 2.18.1 Principles of toxicity scoring systems used in current clinical practice including selection of appropriate endpoints and quantification
 - 2.18.2 Examples of toxicity scoring systems used in current clinical practice e.g. RTOG, Common Toxicity Criteria, LENT/SOMA
 - 2.18.3 Tolerance doses of normal tissues/organs including the QUANTEC data and its limitations
- 2.19 Radiation carcinogenesis
 - 2.19.1 Concept of stochastic and deterministic effects
- 2.20 Re-irradiation
 - 2.20.1 Re-irradiation tolerance of normal tissues derived from experimental and clinical studies for both early and late effects
 - 2.20.2 Time interval between therapy courses and concept of forgotten dose
 - 2.20.3 The radiobiological principles for consideration of re-treatment including initial radiotherapy dose, volume, volume of overlap and technique used

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- 2.20.4 Effect of radiation modifiers used in treatment of the first tumour e.g. concurrent chemotherapy
- 2.21 Radiobiological principles in brachytherapy, stereotactic ablative radiotherapy, radiosurgery, tomotherapy, IMRT and particle therapy
- 2.22 Oncopathology
 - 2.22.1 Major histological types of cancer
 - 2.22.2 Typical cytological features of malignant cells
 - 2.22.3 Typical biological behaviour of benign and malignant neoplasms
 - 2.22.4 Neoplasia, differentiation, anaplasia, aneuploidy
 - 2.22.5 Cancer stem cells and cancer cell lineages, monoclonality
 - 2.22.6 Tumour heterogeneity
 - 2.22.7 Pathways of spread
 - 2.22.8 Molecular basis of cancer and cancer genetics
 - 2.22.9 Mechanisms of cell death
 - 2.22.10 Tumour immunology
- 3. **Haematological Malignancies**
 - 3.1 **Myelodysplastic Syndrome:** Classification, French-American-British classification, WHO, Myelodysplastic syndrome, unclassified signs and symptoms, pathophysiology, genetics 5q- syndrome
 - 3.2 **Acute and Chronic Leukemia:** Pathology, genetic abnormalities, infective precursors, investigation and evaluate relevant diagnostic tests, including molecular and cytogenetic studies e.g. indicating Ph+ disease; significance of minimal residual disease and the duration of disease remission; uses of radiation therapy, including indications for cranial, craniospinal or total body irradiation in both myeloablative and non myeloablative transplants and total marrow irradiation
 - 3.3 **Hodgkin's Lymphoma:** Pathology, WHO classification system, appropriate staging investigations including the role of PET; contemporary combined modality therapy and the historical changes in the role of radiation therapy in the curative treatment of HL; involved field and involved nodal radiation
 - 3.4 **Non-Hodgkins Lymphomas:** Pathology, WHO classification, appropriate staging investigations (including PET, bone marrow biopsy), stratify patients according to contemporary prognostic groupings, involved field radiation therapy, treatment principles for extranodal lymphomas, indications and techniques for applying fields extending beyond "involved field" radiation therapy, including subtotal nodal irradiation, total nodal irradiation and TBI, role of chemotherapy, molecularly targeted agents and radioimmunotherapy
 - 3.5 **Myeloproliferative Disorders:** Classification, causes, diagnosis chronic myelogenous leukemia, essential thrombocythemia, polycythemia vera, primary myelofibrosis, treatment
 - 3.6 **Stem cell Transplant:** Normal haematopoiesis and stem cell biology, principles and practice of HSCT, indications and principles of stem cell transplant, sources of stem cells preparative regimen, principles of conditioning radiotherapy, procedure, complications, prognosis
 - 3.7 **Palliative Care:** Introduction, WHO definition; definition and types of pain, pain assessment, use of different pain scales; Palliative measures for other symptoms including: respiratory tract, gastrointestinal tract, neurological symptoms, cutaneous and mucosal symptoms, anorexia, cachexia; Ethical issues in Palliative care; Psycho social issues; Palliative Radiotherapy

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4. Principles and Practice of Radiation Oncology

- 4.1 Anatomy
- 4.2 Diagnostic work up: Radiological, Cyto-Histopathological, Biochemical, Tumor markers, Radio nuclear imaging
- 4.3 Tumor Classifications and Staging Systems (TNM, FIGO)
- 4.4 Management of malignant diseases: Treatment protocols, Sequelae of treatment
- 4.5 Cancers of various organs
- 4.6 System wise disease management
 - 4.6.1 Eye and orbit
 - 4.6.2 Head and neck tumors
 - 4.6.3 CNS tumors
 - 4.6.4 Thoracic tumors
 - 4.6.5 Breast
- 4.7 Pre treatment verification protocols
- 4.8 Treatment delivery protocols
- 4.9 Radiation therapy treatment originating in various sites: treatment for Overall cancer management of various solid tumors
 - 4.9.1 Cancer of Head and neck
 - 4.9.2 Cancer of Lung and Mediastinum
 - 4.9.3 Cancer of Gastro Intestinal Track
 - 4.9.4 Cancer of Genito Urinary System
 - 4.9.5 Cancer of the Breast
 - 4.9.6 Cancer of Endocrine System
 - 4.9.7 Sarcomas of Soft Tissues & Bone
 - 4.9.8 Benign & Malignant Mesotheliomas
 - 4.9.9 Cancer of skin
 - 4.9.10 Malignant Melanoma
 - 4.9.11 Neoplasms of CNS
 - 4.9.12 Cancers of childhood
 - 4.9.13 Lymphomas
 - 4.9.14 Leukemias and other Haematological Malignancies
 - 4.9.15 Paraneoplastic Syndromes
 - 4.9.16 Cancers of unknown primary site
 - 4.9.17 AIDS – related malignancies
 - 4.9.18 Oncological Emergencies
 - 4.9.19 Treatment of Metastatic Cancers
 - 4.9.20 Gynaecological Cancers
- 4.10 Radiotherapy Treatment protocols for treating cancers of various sites
 - 4.10.1 Pre Treatment verification protocols
 - 4.10.2 Importance of Imaging with Computed tomography, MR imaging and PET –CT In radiation Therapy
 - 4.10.3 Sagittal, coronal and axial planes of body
 - 4.10.4 Identification of normal anatomic plane in the Body
 - 4.10.5 Topographic anatomy to locate internal organs of the body
 - 4.10.6 Image formation and orientation for CT, MR, PET and Fusion concepts of various modalities
 - 4.10.7 Basic Principles of Digital imaging
 - 4.10.8 Image acquisition (Simulation, Portal imaging, Online image Guidance)

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- 4.10.9 Digital reconstruction DRR
- 4.10.10 Patient positioning and dynamic target localization
- 4.10.11 Image extraction
- 4.10.12 Quality control of Imaging
- 4.10.13 Computed Tomographic Imaging in radiation oncology
- 4.10.14 Data acquisition (raw data, Beams Eye view)
- 4.10.15 Image reconstruction
- 4.10.16 Image backup and storage
- 4.11 Radiotherapy Treatment Delivery Protocols for malignant diseases of various sites
