Revised Scheme of CMPI Certification Examination

(Implemented with effect from January 2019)

The certification examination of the College of Medical Physics of India (CMPI) is conducted to certify the competency of the candidate in the specialty of Radiation Oncology Medical Physics. The examination contains two parts, namely Part A: Written Examination, and Part B: Oral Evaluation. A candidate needs to successfully complete Part A of the examination to obtain eligibility for appearing in Part B of the examination. Specifically, a candidate scoring at least 50% marks in each of the papers of Part A of the examination will be declared eligible for appearing in Part B of the examination. However, it is required to score at least 60% marks in aggregate to be declared successful in CMPI certification examination. Successful candidates of CMPI certification examination are also enrolled as Member of the College. Following is the details of the examination scheme implemented with effect from 2019:

Part A: The Written Examination (200 Marks)

The written examination consists of two papers:

Paper I: General Medical Physics (including Radiobiology and Radiation Protection) - 100 marks

Paper II: Radiation Oncology Medical Physics - 100 marks

Paper I is designed to test the general knowledge and understanding of a qualified medical physicist in all specialties of the discipline including Radiation Oncology Medical Physics (ROMP), Diagnostic Radiology Medical Physics (DMRP), Nuclear Medicine Medical Physics (NMMP), Basic Radiation Biology and Radiation Protection pertaining to medical applications of radiation. The duration of examination for this paper is two hours (2.0 hrs) and the maximum mark is 100. The question paper contains four sections as detailed below:

Section I: 50 Multiple Choice Questions of one mark each (50x1=50 marks)
Section II: 5 Definitions/Very short answer type questions of two marks each (5x2=10 marks)
Section III: 4 Short answer type questions out of 6 with 5 marks each (4x5=20 marks)
Section IV: 2 Descriptive answer type questions out of 3 with 10 mark each (2x10=20 marks)

The syllabus and sample questions of this paper are given in Appendix-I.

Paper II is a specialty paper which is designed to test the competency of a candidate to work unsupervised as Radiation Oncology Medical Physicist. Complete knowledge of the science and practice of the specialty is required to answer the questions of this paper. The duration of this examination is two and half hours (2.5 hrs) and the maximum mark is 100.

The question paper contains four sections as detailed below:

Section I: 50 Multiple Choice Questions of one mark each (50x1=50 marks)
Section II: 5 Definitions/Very short answer type questions of two marks each (5x2=10 marks)
Section III: 2 Short answer type questions out of 3 with 5 marks each (2x5=10 marks)
Section IV: 3 Descriptive answer type questions out of 4 with 10 mark each (3x10=30 marks)

The syllabus and sample questions of this paper are given in Appendix-II.

Part B: Oral Evaluation (100 Marks)

The oral evaluation consists of following two parts, which will be held in parallel sessions.

Part I: Test of Presentation Skill (25 marks)

This part of the oral evaluation has been designed to test the presentation skill of a candidate. In this mode of examination, a candidate will be given about 12 minutes time to make a presentation on a topic of his/her choice. The topic of presentation could be a brief but complete report on a project work or commissioning and quality assurance (QA) of equipment or paper presented (or to be presented) in national/international conference and published (or to be published) in national/international journals. The candidates are advised to bring the material of presentation in PowerPoint format to make the presentation before a panel of examiners and observers. The panel of examiners and observers will start testing the candidate at the end of the presentation by asking a few questions/clarifications which may last for about 15 to 18 minutes. The questions/clarifications asked by the examiners/observers will be related to the topic of presentation of the candidate. The maximum mark for this part of oral evaluation is 25.

Part II: Test of Practical Knowledge and Skill (75 marks)

This part of the oral evaluation has been designed to test the practical knowledge and skill of a candidate in the specialty of ROMP and associated topics such as radiation protection and safety. In this mode of examination, a candidate will be examined by six different examiners on six different topics on one-to-one basis. The candidate will be examined in each topic for 20 minutes. The following are the six topics on which the candidate will be examined:

i) Radiotherapy Physics and Equipment – Commissioning and QA
ii) Radiation Dosimetry and Standardization – Dosimetric Principles and Dosimeters
iii) Radiotherapy Treatment Planning and Delivery – 3DCRT, IMRT, IGRT, VMAT and ART (or IGART)
iv) Special Techniques in Radiotherapy – SRS, SRT, SBRT, TBI, TSET, TMI and TLI
v) Brachytherapy - Source specifications, Calibration, Dosimetry and Planning Techniques
vi) Radiation Protection and Safety –Radiation Protection principles, Room Design, Shielding and Evaluation

The examiner will ask a few questions to the candidate on the topic allotted to him/her in a randomized fashion from the question bank prepared in advance. Each examiner will have one candidate at time for about 20 minutes. On completion of about 20 minutes of interaction with a given examiner, the candidate will be asked to move to the next examiner. This process of evaluation of a candidate will continue till he/she finishes his/her evaluation by all the six examiners. The maximum mark for this part of oral evaluation is 75.

Appendix-I

Paper I: General Medical Physics (including Radiobiology and Radiation Protection)

Syllabus

(This syllabus is given only as a guideline and the students are expected to refer the standard books)

This paper includes the basics components of Diagnostic Radiology Medical Physics (DRMP), Radiation Oncology Medical Physics (ROMP), Nuclear Medicine Medical Physics NMMP), Radiobiology and Radiation Protection and Safety pertaining to medical applications of radiation. It is expected that candidates will refer standard text books on these topics (e.g. IAEA handbooks on ROMP, DRMP, NMMP and Radiobiology). Following are the brief syllabi of General Medical Physics, Radiobiology, Radiation Protection and Safety:

Radiological physics pertaining to ROMP, DRMP and NMMP:

Radioactivity: Fundamentals of Atomic and Nuclear physics - Natural and artificial radioactivity - Types of radioactive decay - Laws of radioactive disintegration - Physical - biological and effective half-lives - mean life (τ) - total and partial decay constants - Radioactive equilibriums - Types of nuclear reactions - Principles of radionuclide production - Radioactivation by nuclear interaction and Exposure rate and Air-kerma rate constants.

X-rays Production and Quality: Principles of kilovoltage (kV) X-ray generation and X-ray generators - Bremsstrahlung (or continuous) and characteristic X-rays - Efficiency of X-ray production and its dependence on electron energy and target atomic number - X-ray machines used for therapy and X-ray machine used in radiation therapy - Clinical use of narrow fan beam and broad cone beam X-rays - Beam filtration and Beam quality specifications for kV X-ray beams.

Interaction of photons with matter: Types of interactions and their relative importance - Exponential Attenuation - Narrow beam and broad beam geometries - Attenuation coefficients - Total coefficients for Attenuation - Energy transfer and Energy Absorption.

Interaction of charged particles with matter: Types of interactions for electrons - protons - and heavy charged particles - soft and hard collisions - Nuclear interactions - Collision losses - Radiative losses - Total Energy losses - Stopping power for electrons and heavy charged particles - Mass-collision Stopping power for heavy charged particles - Shell correction - Restricted stopping power and continuous slowing down approximation (CSDA) - CSDA range for electrons and heavy ions - Straggling and Multiple scattering.

Physics of Diagnostic Radiology Imaging: Conventional Radiography - Mammography – Fluoroscopy - Computed Radiography - Digital Radiography - Computed Tomography - Magnetic Resonance Imaging - Ultrasound.

Physics of Nuclear Medicine Imaging and Internal Dosimetry: Radioisotopes used in Nuclear medicine - Production of Radionuclides specific to imaging in Nuclear Medicine - General concept of Radionuclide imaging - Rectilinear Scanner, Principles and Design of the Anger Camera/Scintillation Camera and Detector systems - Focal Plane Tomography - Single

Photon Emission Tomography - Positron Emission Tomography (PET) - PET/CT Hybrid Imaging - Isotope generator - Calibration of Radioisotopes - Radiation Dosimetry in Nuclear Medicine - Internal Dosimetry - Radioimmunoassay (RIA) / Immunoradiometric assay (IRMA) techniques and its principles.

Radiobiology:

Fundamentals of Radiobiology: Biological modifiers- Cellular kinetics - Cell cycle and cell death - Cell cycle control mechanisms of normal and tumor cells - Radiation interaction with tissue - Radiation effect at cellular level - Radiation effects on human tissue - organs and malignant cells - Types of radiation damage - Tissue structure and radiation effect - Radiation effect on the fetus - Chromosome Damage and Repair - Law of Bergonie and Tribondeau - Five R's of Radiobiology - Effects dose rate and fractionation - Tumor control and normal tissue complication (TCP / NTCP) and Therapeutic ratio.

Radiobiological Concepts: Radio-sensitizers and protectors - Reduction of side effects - Linear energy transfer (LET) - Radiobiological effectiveness (RBE) - Oxygen effect - Oxygen enhancement ratio (OER) - Radiobiological models - Cell survival curves - Time Dose Fractionation (TDF) - Linear Quadratic (LQ) model and its application in radiotherapy - early and late effects of radiation - Various fractionation regimens/strategies.

Radiation Protection and Safety:

Fundamentals of Radiation Protection: Radiation protection - Historical development - Principles of radiation protection and units - Equivalent dose - Effective dose - Radiation weighting factors - Tissue weighting factors - Dose equivalent limits - Radiation effects - Somatic and genetic effects - Classification of radiation effects: Stochastic effects and tissue reactions (formerly known as deterministic effects) - justification - optimization and dose limits - Regulatory requirements - recommendations and guidance on radiation protection and safety by International Commission on Radiological Protection (ICRP) and Atomic Energy Regulatory Board (AERB).

Radiation Safety in Radiotherapy: Protective materials - Handling of brachytherapy sources - Basic safety standards (BSS) and ICRP 60 and 103 - Radiation facility room design, shielding calculations and evaluations: Teletherapy facility room design for telecobalt unit and linear accelerator including and Neutron shielding in linear accelerator - Brachytherapy facility for low dose rate and high dose rate (LDR and HDR) - Medical exposure - Radiation accidents and lessons learnt - Radiation emergencies and Response plans.

Equipments used in Radiation Protection: Large volume ionization chambers - Survey meters - Proportional counters - GM counters - Area zone monitors - Contamination monitors - Personal monitoring devices: Film badge - Thermoluminescence Dosimeters (TLD) - Optically Stimulated Luminescence dosimeter, Radiophotoluminescent dosimeters and Pocket dosimeters - Neutron detectors/monitors.

Transport of Radioactive Materials: Modes and Methods of Radioactive material transport - Classification of radioactive packages for transport - Procedures for preparing the radioactive packages - Transport of shielded and unshielded radioactive materials and Dose limits - Transport index and radioactive package categories - Regulatory requirements for transport of

radioactive materials: National and international standards - IAEA and AERB safety standards and Radiological Emergency preparedness.

Regulatory Requirements: Physical protection of sources - Safety and security of sources during storage and use - Security provisions - Administrative and technical - AERB guidelines for security of radioactive sources in radiation facilities - Security threat and Graded approach in security provision - National legislation - Regulatory framework - Atomic Energy Act - Radiation protection rules (RPR) - Applicable Safety Codes - Standards - Guides and Manuals - Regulatory Control: Licensing - Inspection and Enforcement - Responsibilities of Employers - Licensees - Radiological safety officers (RSO) and Radiation Workers - National inventories of radiation sources - Import and Export procedures.

SAMPLE QUESTION PAPER

Section I: Answer ALL questions (Encircle the correct answer) 50x1 = 50

(*Only 20 questions are given here as sample*)

1. The factors which determine X-ray production efficiency of a diagnostic X-ray machine

   a) Tube voltage (kVp) and the atomic number (Z) of the target
   b) Tube voltage (kVp) and tube current (mA)
   c) Tube voltage (kVp) and atomic mass (A) of the target
   d) Tube voltage (kVp), tube current (mA) and the atomic number (Z) of the target
   e) Only Tube voltage (kVp)

2. The amount of scatter dose received by a conventional radiograph does not depend on

   a) kV_p b) Focal spot size c) Collimation d) Patient size e) mAs

3. Entrance skin exposure (ESE) for a single 10 mm CT slice of the head is about 4R. The ESE for 15 contiguous slices will be approximately

   a) 4R b) 5R c) 16R d) 40R e) 60R

4. The modulation transfer function (MTF) is a tool for describing the

   a) Properties of the H&D curve of an imaging system
   b) Noise content of an imaging system
   c) Latitude of an imaging system
   d) Effect on sharpness of combined imaging system
   e) Contrast to noise ratio of an imaging system

5. Where do MRI signals come from?

   a) Hydrogen atoms (H)
   b) Water molecules (H_2O)
   c) The hydrogen nucleus (^1H)
   d) Both hydrogen and oxygen atoms
   e) None of these

6. Changing from a 2 MHz to a 5 MHz ultrasound transducer would generally produce

a) Faster imaging
b) high degree of penetration
c) Shorter wavelengths
d) Deep abdomen imaging
e) None of these

7. The principal disadvantage in using a high resolution collimator on a gamma camera is its

a) Limited field of view
b) More distortion
c) Less scatter rejection
d) Lower sensitivity
e) Reduced magnification effect

8. In Positron Emission Tomography (PET) the image is created by detection of

a) Positions
b) Augur electrons
c) Characteristic X-rays
d) Annihilation photons
e) Positrons

9. An alternative to the emission of a characteristic X-ray is

a) Internal conversion
b) K-capture
c) Auger electron
c) Isomeric transition
e) Continuous X-ray

10. The binding energy per nucleon in a nucleus

a) Is proportional to the Coulomb interaction between nucleons
b) Is the same for light and heavy nuclei
c) Is affected by the structure of electron shells in the atom
d) Determines the stability of the nucleus
e) Decreases as the atomic number increases

11. In a t-test looking for a statistically significant difference between two experimental results claims of such a difference with a p-value of 0.01

a) Means there is unquestionably a difference between the two results
b) Allows the experimenter a wider latitude of error than would a p-value of 0.05
c) Means there is a 99% chance that the claim is true
d) Means there is a 99% chance that the claim is incorrect
e) Means there is a 10% difference between the two results

12. The Use factor (U) taken for calculating thickness of primary wall of a standard LINAC facility is

a) 1 b) ½ c) ¼ d) 1/16 e) 1/8

13. The Radiation protection quantity which is used to estimate the cancer risk from X-ray irradiation of occupational worker is

a) Exposure (X) b) Equivalent Dose (H)
c) Effective Dose (E) d) Absorbed Dose (D)
e) Collective Effective Dose (S)

14. The dose to a resident's hands from a brachytherapy procedure is 25 mSv. The number of procedures that the resident can perform per year without exceeding the recommended dose limit is

a) 1 b) 2 c) 4 d) 10 e) 20

15. A 0.5 mm lead equivalent protective apron is an effective protection device when working with

a) A patient with ^{192}Ir implant b) Diagnostic X-rays
c) With ^{131}I therapy administration d) Positrons
e) Telegamma therapy

16. The term CHART stands for

a) Continuous Hyper-fractionated Accelerated Radiation Therapy
b) Conformal Hyper-fractionated Accelerated Radiation Therapy
c) Conformal Hyper-fractionated Altered Radiation Therapy
d) Continuous Hyper-fractionated Altered Radiation Therapy
e) Continuous Hypo-fractionated Accelerated Radiation Therapy

17. The average latent period for cataract to appear in patients who had received 2.5 to 6.5 Gy

a) 2 years b) 4 years c) 8 years d) 16 years e) 20 years

18. OER approaches unity for LET value of about

a) 10 keV/µm b) 100 keV/µm c) 160 keV/µm d) 180 keV/µm e) 0.3 keV/ µm

19. The use of BED is to determine

a) Equivalent fractionation schemes b) Over all treatment time
c) Treatment outcome d) a and b
e) a and c

20. The cell survival data are represented by the linear quadratic relationship by

a) $S= e^{(\alpha D - \beta D^2)}$ b) $S= e^{-(\alpha D + \beta D^2)}$ c) $S= e^{(\alpha D^2 - \beta D)}$ d) $S= e^{(\alpha D^2 - \beta D^2)}$ e) $S= e^{-(\alpha D^2 - \beta D^2)}$

Section II: Answer ALL the questions **5 x 2 = 10**

1. What do you mean by a double strand break?
2. What is a pulse height analyzer?
3. Who is a classified Radiation worker as per RPR 2004?
4. What is SNR in MR imaging?
5. What is DICOM and its advantage?

Section III: Answer ANY FOUR questions **4 x 5 = 20**

1. Sketch the cell survival curves for single and fractionated regimens and compare?
2. Write a short note on internal amplification in gas filled detectors?
3. Outline AERB guidelines for providing Air Conditioning in a Teletherapy facility?
4. What is Digital Radiography and how is it different from Computed Radiography?
5. Explain different types of collimators used in gamma camera?
6. What is a Helical CT?

Section IV: Answer ANY TWO questions **2 x 10 = 20**

1. (a) Write a note on radiation weighting factors (W_R) giving the values for various types of radiation and the basics on which the ICRP has arrived at these values. What are the major changes in Radiation weighting factor as per ICRP 103?

   (b) Calculate the equivalent dose (H) for a person exposed to 20 mGy of 1 MeV Neutron, 10 mGy of α-rays and 5 mGy of 6 MV X-rays?

2. (a) Derive the equation for Biologically Equivalent Dose (BED)?

   (b) Calculate the BED for early and late effects for hyper fractionation schedule of 70 fractions of 1.15 Gy given twice daily, 6 hours apart, 5 days per week, an overall treatment time of 7 weeks. What do you infer from the BED values arrived at?

3. Explain with the help of a block diagram the working of a Gamma Camera?

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Appendix-II

Paper II: Radiation Oncology Medical Physics

Syllabus

(This syllabus is given only as a guideline and the candidates are expected to refer standard text books and current literature)

Radiation Dosimetry fundamentals and Dosimeters: Concepts of description of ionizing radiation fields and its interaction with matter - Energy transferred - Net energy transferred and imparted - Kerma - Absorbed dose - Exposure – Concept of W value - Measure of activity and apparent activity - Air kerma rate constant - Reference air kerma rate - Quantities and units used in Radiation protection such as Equivalent Dose and Effective Dose. Charged particle equilibrium (CPE) - Transient CPE (TCPE) - Stopping power ratios. Cavity theories: Bragg Gray Cavity theory - Spencer Attix Cavity theory - Burlin cavity theory - Measurement of absorbed dose in a medium - General Guidelines on Radiation Dose Measurement - Characteristics of Radiation Dosimeters: Accuracy and precision - Stability - Dose Linearity and Dose Rate Dependence - Energy dependence - Directional Dependence and Spatial Resolution - Dosimeters: Calorimeters - Ionization chambers: Free Air Chambers - Cylindrical chambers - Plane Parallel chambers - well-type chambers and Extrapolation chambers - Semi-conductor Dosimetry - Luminescence Dosimetry: TLD and OSLD - Film Dosimetry - Chemical dosimetry - Gel dosimetry - Diamond detectors - Scintillation Detectors - Detector arrays - Planar and volumetric dosimetry - Neutron dosimeters and Radiation Protection dosimetry: Pocket Dosimeters - Area Survey meters and Contamination Monitors.

Dosimetric parameters, standards and Protocols: Primary and Secondary Standard Dosimetry - Traceability - Uncertainty in measurement - Phantoms - Measurement of beam quality - Central axis dosimetric parameters (PDD, TAR, TPR and TMR etc) - Dosimetry under reference and non-reference conditions - Various Calibration coefficients (N_x, N_k, $N_{D, air}$ and $N_{D, W}$) - $K_{Q, Qo}$ - Cross calibrations - Determination of absorbed dose to water - IAEA TRS 398 and AAPM TG 51 protocols - Specification and calibration of brachytherapy sources - reference air kerma rate (RAKR)/ Air kerma strength (AKS) for sealed and unsealed radionuclide - IAEA TECDOC 1274 and ICRU 72 recommendations - Point and line sources dosimetry formalisms - Sievert integral - AAPM TG-43/43U1 and other dosimetry formalisms. Special dosimetry protocols: Small static field dosimetry - IAEA TRS 483 – AAPM TG 155 - Heavy charged particle beam dosimetry and beam quality specifications.

External Beam Therapy: Kilo voltage therapy X-ray Units - Design and operation of Orthovoltage and Superficial therapy units - Spectral distribution of kV x rays and effect of filtration - Telegamma units: Construction and working of Cesium-137 and Cobalt-60 teletherapy units - Vaults design - Beam shutter mechanisms - Medical Accelerators: Electron Linear accelerator - Microtron - Betatron and Cyclotron facility design - Specifications - Installations - Acceptance testing – Commissioning, QA and QC - Safety considerations - Clinical aspects of Photon, Electron and Hadron therapy - Beam properties.

Beam Modification Techniques: Alloy Blocks - Penumbra trimmers - Shielding - Physical hard wedges – Dynamic and Motorized wedges - Tissue Compensating filters - Different methods of intensity modulation - Effects on dose distribution - Methods of compensation for patient contour variation and/or tissue inhomogeneity - Bolus - Buildup materials.

Imaging, Target delineation and Treatment Planning: Patient data acquisition techniques - Patient positioning and Immobilization methods - Lasers - Determination of body contour and location of internal structures - Target volume and critical tissues. Imaging for radiotherapy planning Plain film - fluoroscopy - Conventional Simulators - CT simulators - MR Simulators - Ultrasonography - SPECT - PET - Hybrid imaging - Specification of Tumor dose - ICRU Reports – ICRU 50 & ICRU 62 terminology - Functions used in dose calculation - Correction and model based dose calculation algorithms - Isodose charts (SSD and SAD) - Manual and computerized planning techniques - Conventional and conformal treatment planning techniques - Methods and combination of beams - Static and Dynamic Arc therapy techniques - Dose calculation methods - Inhomogeneity corrections - Forward and Inverse planning techniques.

Advanced Treatment Planning and Delivery Techniques: Networking in Radiotherapy - Medical image handling and formatting - DICOM - DICOM RT - Radiation Oncology information management system – Electronic record managements - Advanced Treatment techniques and calculations: IMRT, IGRT, VMAT, Adaptive RT – Various dose calculation algorithms - Dose Calculation in Homogeneous and heterogeneous Media - Superposition and Convolution Algorithms - Pencil Beam and Path Length Scaling - Collapsed Cone and Kernel Tilting – Monte Carlo calculations - Inverse plan optimization techniques - Plan Evaluation techniques and parameters for plan evaluation - Biological model based optimization, planning and evaluations - Pretreatment Online/Offline image guidance: Portal films - portal imaging - Electronic portal imaging devices (EPID) - Type of EPIDs - 2D Image guided radiotherapy - 3D image guided radiotherapy - kV cone beam CT - MV Cone beam CT, In room CT and MRI and other offline/online image guidance techniques.

Electron Beam properties and Clinical Applications: Energy spectra - Energy specification - Variation of mean energy with depth - Suitability of measuring instruments for electron beam dosimetry - Characteristics of electron beams - Surface dose - percentage depth dose - beam profiles - isodose curves and charts - Flatness and symmetry - Beam collimation - Variation of percentage depth dose and output with field size and SSD - Photon contamination - Treatment planning - energy and field size choice - air gaps and obliquity. Tissue inhomogeneity - lung - bone - and air filled cavities. Bolus - Field junctions (with either electron or photon beams) - Internal shielding and Arc therapy.

Brachytherapy: Radionuclides used for Brachytherapy: Gamma sources - Caesium-137 - Iridium-192 - Gold-198 - Cobalt-60 - Iodine-125 - and Palladium 103. Beta sources - Strontium-90 - Yttrium- 90 and Ruthenium-106 - Production of these radioactive sources - Source construction including filtration - Physical Properties - Spectra of radiation emitted - half-life and specific activity - Comparative advantages of these radio nuclides. Brachy room design, shielding and evaluation - Basic principles - Surface - interstitial - intracavitary - intravascular and intraluminal techniques - Low - medium - high and pulsed dose rate brachytherapy - Remote afterloading machines and manual afterloading - Brachytherapy dosimetry - AAPM TG 43 formalism - Dosage systems - Manchester system - Paris system -

Methods of reconstruction - Optimization in Brachytherapy and dosage calculation using radiography - CT and MRI - ICRU dose specification system - Stereotactic technique - X-ray brachytherapy - Beta-particle brachytherapy - Methods of use and dose distribution - Handling - Calibration - Cleaning - Inspection - Storage and transport of brachytherapy sources.

Special Procedures: Stereotactic Radiosurgery/therapy (SRS/SRT), Stereotactic Body Radiotherapy including CyberKnife, gamma knife and Linac based planning and delivery techniques - Special localization frames and immobilization devices - static and dynamic delivery techniques - TBI, TSET, TMI and TLI - Patient repositioning - Commissioning and QA - in vivo dosimetry protocols - IAEA and AAPM recommendations – Clinical Dosimetry - Treatment planning and QA - Rationale for Proton therapy and Carbon ion therapy techniques - Boron Neutron Capture therapy - Photodynamic therapy techniques - Monoclonal antibodies.

Quality Assurance (QA): Equipment specific QA in RT: Periodic (Daily, weekly, monthly and annual) QA for teletherapy and brachytherapy facilities - AAPM TG 142 and TG 148 - TPS QA - Simulation and Imaging facilities - MV Beam quality checks - Dynamic MLC performance test - QA for in-room kV imaging systems - EPID - QA of TPS - Isocentre verifications. Patient specific QA in RT: Pretreatment QA of IMRT and VMAT delivery - Planar and Volumetric dose distribution verification test procedures - IAEA TRS 430 - AAPM TG 218 - Equipments used for Patient specific QA programs - Pretreatment QA for SRS/SRT/SBRT.

SAMPLE QUESTIONS

Section I: Answer ALL questions. ENCIRCLE correct answer. 50 x 1 = 50
(Only 20 questions are given here as sample)

1. Which of the following is not an accelerator component?

a) Waveguide b) Transducer c) Modulator d) Thyratron
e) Scattering foil

2. The advantages of Flattening Filter Free Beam are

i) Higher dose Rate
ii) Lesser scatter radiation
iii) Higher Percentage Depth Dose

a) i alone is correct
b) ii & iii are correct
c) i & ii are correct
d) i & iii are correct
e) i, ii and iii are correct

3. The side of the equivalent square of a 8 x 30 cm^2 field is

a) Approximately equal to $\sqrt{(8x30)}$
b) Closer to 30 than 8

c) The square field which has the same PDD as the rectangle
d) Approximated by the area / perimeter of the rectangle
e) Approximately equal to 19 cm

4. As photon energy increases from 6 MV to 15 MV all the following occur except

a. The depth of d_{max} increases
b. The linear attenuation increases
c. The neutron dose increases
d. The PDD and TMR at 10 cm depth increases
e. The horn effect at shallow depth increases

5. The dose under a 1.5 cm width cord block (5 HVL thickness) in a 15 x 15 cm^2 6 MV photon beam at 5 cm depth due to transmission plus scatter is approximately_____ & of the dose in the open beam

a) 3 b) 7 c) 15 d) 30 e) 50

6. Achromatic bending of electron beam in Linear accelerator is at

a) 45^o b) 90^o c) 270^o d) 180^o

e) 120^o

7. It has been recommended that the dose to the pacemaker be kept below 2.0 Gy. In a lung treatment of 40Gy with 6 MV photons, the fields should be no closer than_____to the pacemaker

a) 0.5 cm b) 2.0 cm c) 7.0 cm d) 15.0 cm
e) 10 cm

8. Soft tissue contrast is better in a spiral CT than in a kV cone beam CT scan because

a) Spiral CT uses a lower energy beam
b) There is more scatter radiation in a cone beam scan
c) Spiral CT scans give higher patient doses
d) Slice thickness is less on Spiral CT
e) Fast scanning is used in Cone beam CT

9. The correct ordering of imaging modalities from poorest to best resolution is

a) PET, CT, Film b) Film, PET, CT c) Film, MRI, CT d) MRI, PET, Film
e) PET, Film, CT, MRI

10. The total dose from a permanent seed implant is 1600cGy. The half-life is 17 days. The total dose delivered in the first 34 days is____cGy

a) 1400 b) 1200 c) 800 d) 400 e) 1800

11. When a linac calibration is performed with an ion chamber, temperature and pressure corrections are applied to account for expansion or contraction of

a. The chamber wall material
b. The gas in the ion chamber
c. The phantom
d. Changes in the cables between the chamber and electrometer

e. The thin central electrode

12. Radiochromic films offer the following advantages as dosimeter, ***except***

a) High resolution
b) Tissue equivalence
c) Small dependence on photon energy
d) High sensitivity
e) Instant read out

13. A physicist is checking the MU for a computer-generated plan of breast tangents, using a reference point in the centre of the breast. The hand calculation gives a lower MU setting by 3%. Possible reason for this is

a) Lack of scatter to the reference point from the part of the tangent in air is accounted for in the plan, but not in the hand calculation
b) The plan is calculated using a rectangular field, while the hand calculation uses an equivalent square field.
c) Beam hardening in tissue is not accounted for in the hand calculation
d) The hand calculation does not correct for increased scatter from the lung /chest wall interface
e) Due to oblique incidence of the beams

14. It is difficult to visualize small bony structures on an 8-MV portal film because

a. The Compton process predominates at this energy
b. Equal masses of bone and soft tissue will absorb equal numbers of photons
c. Most of the interactions will be independent of Z
d. Beam transmission through the bone structure will also be increased
e. All of the above

15. When treating a small lung lesion which moves with respiration, which of the following techniques can be used without a gating system or spirometer?

a. Deep inspiration breath hold for CT and treatment
b. Binning the CT into segments of breathing cycle & planning with selected segments
c. PTV created by leaving margin around maximum tumour excursion observed under fluoroscopy
d. a and c is correct
e. All of the above

16. Which of the following has the highest skin dose for a 10 x 10 cm^2 field at 100 cm SSD?

a) 6 MV photons b) 18 MV photons c) 6 MeV electrons d) 20 MeV electrons e) 10 MV photons

17. For Total Skin Electron Beam (TSEB) Therapy, a large 1 cm thick Lucite screen is often placed in front of the patient to

i. Protect the patient from scattered radiation
ii. Energy degrader
iii. Decreases depth dose
iv. Increases dose uniformity

a) i) & ii) are correct b) i), ii) and iii) are correct
c) ii), iii) and iv) are correct d) i and iv are correct e) All are correct

18. Historically, ^{137}Cs activity has been expressed in terms of mg-Raeq because

a) The activity in mCi is difficult to determine
b) The gamma ray energy is the same
c) Patterson Parker tables designed for radium could be used
d) Shielding requirements are the same for 1 mg radium and 1 mg Raeq of ^{137}Cs
e) ^{226}Ra and ^{137}Cs have more or less similar energy spectrum

19. A physicist measures the output of a linac and finds it to be 2.2% low. The usual action taken by the physicist is

a. To change the tables of output factors to the new measured values
b. Nothing is changed as it is within 5%
c. All patients treated since the last monthly calibration spot check must be notified
d. A potentiometer is adjusted so that one monitor chamber unit is equal to 1 cGy measured at the reference point
e. 0.2% correction must be applied for total MU of each patient plans

20. The rapid dose fall-off with distance around a ^{137}Cs source in tissue is mainly due to

a) Tissue attenuation b) Inverse square effect
c) Short range of the betas d) The Attenuation in the source encapsulation
e) Tissue heterogeneity

Section II: Answer ALL the questions **5 x 2 = 10**

1. Define stopping power of a medium
2. The source in a cobalt-60 unit is 2 cm in diameter, the SSD is 80 cm and the SDD is 50 cm. What is the size of the penumbra at the surface of the patient?
3. Where X-band Linacs are used and why?
4. Define practical range of a clinical electron beam. What is the practical range of a 12 MeV electron beam?
5. Define Clinical Target Volume (CTV)

Section III: Answer ANY TWO questions **2 x 5 = 10**

1. Compare standing and traveling waveguide LINACs?
2. Explain why thick target is used in linear accelerator?
3. With a diagram explain extra-focal radiation?

Section IV: Answer ANY THREES questions **3 x 10 = 30**

1. a) How does X-ray contamination of clinical electron beams happen and which component contributes maximum to this?
b) What are the techniques to produce clinical (broad) electron beam from pencil electron beam in a linear accelerator? Compare both the techniques?

2. Draw the graph for total mass attenuation coefficient for water and lead and explain relative importance of Photoelectric, coherent, Compton and pair production

3. Draw a neat cross sectional diagram of a parallel plate chamber. What is the electrode spacing in a Parallel plate chamber? (c) Explain the advantages of using the parallel plate chamber for electron beams (d) what are its applications?

4. Where are the MLCs placed in the linacs of Varian and Elekta machines? Discuss the issues related to the position of the MLC in linac? Compare the advantages and disadvantages of these designs.