Certification Examination of the College of Medical Physics of India

The term **Radiological Physics** includes subspecialties viz. Radiation Oncology Physics, Imaging Physics and Nuclear Medicine Physics.

The College of Medical Physics of India will initially certify candidates in the specialty of Radiation Oncology Physics as majority of Medical Physics in India are in this field.

1. The Certification:

Certification by the College of Medical Physics of India (CMPI) as envisaged in the constitution will be performed by examination. The certification by CMPI means that the candidate has met certain minimum requirement that the Board of CMPI considers is required to attain expertise in Radiation Oncology Physics.

2. The Examination:

The certification examination of the College of Medical Physics of India will examine the candidate for competency in all aspects of that specialty. The examination will be in two parts. Part I will be written examination consisting of *three* written papers and Part II will be an *oral* examination. The candidate will have to successfully complete Part I to appear for Part II.

2.1 Eligibility for certification examination: Eligibility to appear for the certification examination of the CMPI is provided in the constitution of the College. In case of candidates having Medical Physics qualification and experience from outside India, eligibility will be decided case by case basis by the board. The decision of the board will be final.

3. Applying for Permission to appear for Examination:

Candidates wishing to apply for certification examination should send the application in the prescribed format with necessary documents to the Registrar, College of Medical Physics of India, along with an application processing fee of Rs 500. The fee could be paid in the form of DD in favor of College of Medical Physics of India, payable at Mumbai. Registration number will be issued by the registrar

4. Scrutiny of Applications:

Registrar of the College will scrutinize the applications and accord permission to appear for the examination as per the requirement given in the constitution and in consultation with the members of the board. The Registrar will individually communicate to each candidate.

5. Validity of Permission to appear for examination:

5.1 Candidates who were permitted to take the Certification examination by the Registrar are expected to take up the examination within the next three years.

5.2 The permission given by the registrar will be valid only for a period of three years. If the candidate does not complete the membership examination within three years after obtaining permission, he / she will have to re-apply to the registrar for permission to take up the CMPI examination.

5.3 In case the candidate could not appear for the examination after paying the examination fee given in section 6.1 or is not successful in the examination, will be permitted to appear for the examination during the subsequent two years (see section 5.2), however will have to pay the fees for reappearance to examination, as given in section 6.3

6.1 **Examination Fees:**
The fee for written examination is Rs 2000 /- and the fee for oral examination is Rs 3000/- (total examination fee is Rs 5000 /-). Those who are successful in the written examination only will be permitted to appear for the oral examination.

6.2 The candidates desiring to take only the written examination will have to pay Rs 2000 /- only, however such candidates will have to pay Rs 3000 /- as oral examination fee while appearing for the oral examination. Candidates can pay the fees in total or in parts as given above.

6.3 *Reappearance in the Examination*: Candidates who were not successful in the previous year and would like to take the examination during the subsequent years will have to pay 50% of the examination fee. However, these candidates need to apply to the registrar for permission if three years have elapsed after their previous permission. Maximum number of reappearance will be only three.

6.4 *Examination fee for NRI candidates*: The fee will be twice that of the Indian candidates for NRI candidates wishing to take examination of CMPI in India.

7. Panel of Examiners:

A panel of examiners will be appointed by the Chief examiner in consultation with the members of the Board. The examiners will have to be senior members, preferably members of the College. The Chief Examiner may also appoint an international examiner who are certified by the board in their respective country and have involvement in the Medical Physics activities in India (Members of AMPI). This panel of examiners will be responsible for setting up the question paper, evaluating the answer papers and for conducting the oral examination.

8. Honorarium for examiners & Invigilators:

Honorarium will be paid to the examiners for setting up of the question paper, for invigilation, for evaluating the answer scripts and for conducting the oral examination.

For setting up of question paper	: Rs 500 /	- per question paper
For evaluating the answer papers	: Rs 100 /	- for each answer paper corrected
For Invigilators	: Rs 500/	- for conducting one day written exam
For oral examination	: Rs 1000 /	- per day of sitting

Travel for examiners for oral examination: Examiners invited to conduct oral examination will be eligible to claim III A.C train fare by the shortest route from their home town to the examination center. Accommodation allowance of Rs 500 /- for the day of examination could be claimed.

Part I – Written Examination.

8.1 Written examination & Method of evaluation:

The written examination will be conducted in major cities across the country on the same date. The date and centers where the written examination will be held would be decided by the Board of the College and announced three months before the date of the examination. Written examination for all the *three* papers will be held on the same day. Paper I and II in the morning and Paper III will be in the afternoon.

Paper I – General Medical Physics. This paper will be designed to examine the candidate in general medical physics that will include Radiation Oncology Physics, Imaging Physics and Nuclear Medicine Physics. Basic Knowledge of all these three specialties will be required to write this paper. There is no specific syllabus for this paper.

The duration of this paper will be **one and half hours and the total marks will be 75**. This paper will have three sections

Section I- Twenty five Multiple Choice Questions (MCQs) for one mark each (Total 25 marks)
Section II – Five Definitions / short answers for two marks each (Total 10 marks)
Section III - Four short answers (out of six questions) for 5 marks each (20 marks)
Section IV - Two descriptive answer questions (out of four) for 10 marks each (20 marks)

Paper II. – Radiobiology and Radiation Protection: This paper will be designed to examine the candidate on Basic Radiobiology, general radiation safety aspects and radiation safety related to that particular specialty. The syllabus for this is provided in appendix I. The duration of this paper will be **one and half hours for total marks of 75**.

This paper will have

Section I – Twenty five MCQs for one mark each (Total 25 marks)
Section II – Five Definitions / short answers for two marks each -Total 10 marks
Section III – four short answers (out of six questions) for five marks each – 20marks
Section IV - Two descriptive answer type questions (out of four) for 10 marks each- 20 marks

Paper III – Specialty Paper (Radiation Oncology Physics): This paper is to examine the candidate in that particular specialty. Complete knowledge of the science and practice of the specialty will be required to write this paper. The syllabus for this paper is given in appendix II, in addition the candidates are asked to look at the IAEA syllabus available at the IAEA website (www.iaea.org). The duration of this examination will be for **two and half hours for total marks of 100.**

The syllabus is given in Appendix II.

Question paper pattern for the above written paper will be as follows

Section I – Twenty five MCQs for one mark each (Total 25 marks)
Section II - Five Definitions / short answers for two marks each (Total 10)
Section III- Five short answer questions (out of 7) each carrying 5 marks– Total 25 marks
Section IV - Four descriptive answer type questions (out of 6) each carrying 10 marks- Total 40 marks. (A question bank will be available with the CMPI for this paper)

8.2 Minimum requirement to be successful in the examination:

A candidate will be considered successful if he / she scores 50% in each of the papers and 60% in aggregate. Failure in any one or more of the papers would result in reappearing in all the three papers. Marks of paper I and II will be converted 100%.

8.3 Question Paper Setting and Evaluation Method:
The question papers will be set by a panel of examiners appointed by the Chief Examiner of College. A question bank will be made available to the Medical Physics community for the specialty paper for essay type questions. However it is not guaranteed that the questions will be only from the question bank. The Chief examiner will finalize the question papers. Each answer paper will be evaluated by two examiners. No re-evaluation of the paper will be accepted. In case of disputes, the decision of the board will be final.

8.4 Written examination rules: Following will be the rules for written examination

i. Paper I and Paper II will be in the forenoon between 9 am to 12 noon. Paper III will between 2 pm and 4.30 pm
ii. Entry to the examination hall will be permitted only with a valid hall ticket issued by the board of the CMPI
iii. The candidate should also sign the role call at the examination hall.
iv. Entry into the examination hall will not be permitted half an hour after the start of the particular paper.

v. Candidate will not be permitted to leave the hall within the first half an hour of the examination.
vi. The written examination will be invigilated by a senior medical physicist appointed by the Chief Examiner.
vii. The candidates will not be permitted to take any electronic equipment into the examination hall except a calculator. Calculator having functions other than calculation will not be permitted into the examination hall.
viii. If the invigilator suspects malpractice by any of the candidates, he/she may write a report to the Chief examiner with his signature and with a signature of a witness. If possible the candidate accused should be asked to sign the report. The invigilator shall permit the candidate to complete the examination. However, the results of such candidates will be withheld until an enquiry.
ix. A panel to enquire into such cases will be constituted by the board
x. If the candidate is found guilty by the panel, he/she will be debarred from appearing for the certifying examination.

9. Part II – Oral Examination:

Candidates who have successfully completed the written examination will have to appear for an oral examination to complete the certification process. Oral examination preferably be conducted a day before the annual conference at the same city where the conference is to be held. The number of days of the oral examination will be decided by the panel of examiners depending on the number of candidates. Oral examination will have two sessions and the total duration of oral examination per candidate will be one hour. If an examiner has conflict of interest in case of any candidate, the examiner must opt out of the panel for that particular candidate

9.1 Session I:

The candidate will be asked to make a presentation on a topic of interest to the candidate / work done by the candidate/ research topic in his / her specialty for 10 mts. The examiners may ask question or clarification on the presentation for the 5 to 10 minutes.

9.2 The Session II:

Each examiner in the panel will independently ask two to three questions in Radiological Physics and asses the candidate. The questions asked during the oral examination should include practical aspects, clinical aspects, administration, specification of equipment and Radiation safety. The panel of examiners should have a memorandum of understanding in order to maintain a standard in examination process. The number of oral examiners will be seven.

10. Written Examination Centers for 2010 certifying examination:

The proposed centers for the written examination for the year 2010 will be, New Delhi, Mumbai, Hyderabad, Kolkatha, Bangalore and Chennai. The candidate may give two

choices for the written examination centers. However if there are not enough candidates for a particular center, the board will cancel the center and assign an alternate center for the candidate.

11. Calendar for the Examination Process (Year 2010):

Announcement of Examination & call for application for registration: 23rd December 2009

Last date for submitting application for Registration : 15th February 2010

Information to Candidates about their eligibility : 15th March 2010

Last date for paying written examination fee : 12th April 2010

Dispatch of Hall ticket to the Candidates : 10th May 2010

Date of written examination : 5th June 2010

Announcement of Results of written exam : 15th July 2010

Last date for Payment of fees for oral examination : 10th August 2010

Dates of Oral examination : 16th & 17th Nov 2010

Announcement of results of oral exam
and induction into College as Member :18th Nov 2010

Appendix I

Syllabus for Paper II – Radiobiology and Radiation Protection

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

1. **Biological modifiers and Cell Kinetics**
   Biological modifiers, Cell kinetics, Cell cycle control mechanisms.

2. **Radiobiological Effects**
   Radiation effect at cellular level, Radiation effect on human tissue, Radiation effect on organs, Radiation effect on malignant cells and tissues.

3. **Fundamentals of Radiobiology**
   Five R's of Radiobiology, Tissue structure and radiation effect, Radiation effect on the fetus, Fractionation and its effect, TCP / NTCP.

4. **Radiobiological Concepts**
   Sensitizers, Protectors, Reduction of side effects, Linear energy transfer, (LET) Radiobiological effectiveness (RBE), Oxygen effect, Oxygen enhancement ratio (OER), Radiobiological models, TDF, LQ model, Alpha - Beta concepts.

5. **Fundamentals of Radiation Protection**
   Radiation protection - Historical development, Principles of radiation protection and units, Equivalent dose, Effective dose, Radiation weighting factors, Tissue weighting factors, rem, Sievert, Dose equivalent limits, Radiation effects –Somatic and genetic effects, Classification of radiation effects on dose - Stochastic and deterministic effects, justification, optimization, dose limits, Atomic Energy Regulatory Board (AERB) recommendations.

6. **Radiation Safety in Radiotherapy**
   Protective materials, Handling of brachytherapy sources, Basic safety standards (BSS) and ICRP 60. Room design - Teletherapy units, LDR, HDR and Neutron shielding in linear accelerator. Medical exposure and radiation accidents.

7. **Radiation Protection Instruments**
   Ionization chamber, large volume chambers, Survey meters, Proportional counters, GM counters, Area zone monitors, Contamination monitors. Personal monitoring devices – Film badge, TLD and pocket dosimeters.

8. **Transport of Radioactive Materials**
   Methods of transport, Classification of radioactive packages for transport, Procedures for preparing the radioactive package for transport, Regulatory requirements for transport of radioactive materials – National and international. IAEA safety standards, Emergency preparedness.

9. **Regulatory Requirements**

Physical protection of sources, Safety and security of sources during storage, Use, transport and disposal of sources, Security provisions - Administrative and technical, 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 and Radiation Workers. National inventories of radiation sources, Import and Export procedures

Appendix II

Syllabus for Paper III – Radiation Oncology Physics – Specialty Paper

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

1. Radioactivity

Natural and artificial radioactivity, Modes of radioactive decay, Exponential decay, Physical, biological and effective half-lives, mean life, decay constant, Types of nuclear reactions and Principles of radionuclide production.

2. Production of X-rays for Clinical Use

Production of bremsstrahlung and characteristic radiation by electron bombardment. Efficiency of x-ray production and its dependence on electron energy and target atomic number. X-ray tubes – x-ray tube used for therapy – Quantity and Quality of x-ray beams

3. Photon Absorption and Scattering Processes and Electron Interactions

Attenuation, Energy transfer, absorption and their coefficients. Interaction of Photons with matter – types, properties and their relative importance, mass, electronic and Atomic attenuation coefficient – Total attenuation coefficient, Total transfer and absorption coefficient - Interaction of heavy charged particle with matter – Electron interaction with matter - Energy loss mechanisms: Collisional losses, Radiation losses, Stopping power - Mass collisional and radiative stopping power, LET, Ionization, Excitation, Scattering

4. Radiation Quantities, Units and Measurement

Concept, definition, units of kerma, absorbed dose, dose equivalent, equivalent dose, effective dose, air kerma rate constant, reference air kerma rate, activity and apparent activity – Energy Transfer – Electronic Equilibrium – Bragg Gray Cavity theory – measurement of absorbed dose

5. Radiation Measuring Instruments

Things to consider in Radiation Dosimetry – Dosimetric environment: patients and phantoms

Detectors: Ionization chambers, Semi-conductor detectors, Luminescence Dosimetry, Film Dosimetry, Chemical dosimetry, Gel dosimetry, Calorimetric, MOSFETS, Diamond detectors, Scintillation Detectors, Detector arrays,

Special Dosimetric Measurements: Brachytherapy dosimetry, Neutron dosimetry and Radiation Protection dosimetry

6**. Measurement of Radiation**

Phantoms, Measurement of radiation quality - Output and dose distribution for photon and electron beams. Dosimetry protocols – IAEA 398 and TG 51. TG 43 - Measurement of activity and dose rates for brachytherapy sources and unsealed radionuclides.

7. External Beam Radiation Sources

KiloVoltage x-ray: History, current scenario, Design and operation of Orthovoltage x-rays, superficial X-rays, Orthovoltage unit, Superficial therapy unit,

Tele-Isotope units: Cesium teletherapy unit, Cobalt-60 teletherapy unit, Vaults design, Specification and acceptance testing, commissioning, quality control
Medical Accelerators: Linear accelerator, Medical Microtron, Betatron, - facility design, Photon & Electron beam properties, Specification for Linear accelerator, Installation and acceptance testing, commissioning, Quality assurance, Safety considerations
Beam Shaping: Alloy Blocks, Multileaf collimators (MLCs)
Intensity Modulation: wedges, compensating filters, inverse planning, different methods of Intensity modulation.

8. Dose Distribution and Treatment Planning
Functions used in dose calculation – Derivation and their properties – Treatment planning – Isodose charts – Measurements of these parameters - Treatment planning techniques, methods and combination of beams - Calculation methods – inhomogeneity corrections Specification of Tumor dose – ICRU Reports – ICRU 50 & ICRU 62 terminology - Patient data acquisition techniques - Determination of body contour and location of internal structures, target volume and critical tissues. Imaging for radiotherapy planning Plain film, fluoroscopy, Simulator – CT Simulator - CT, MRI, ultrasonography, nuclear medicine imaging – SPECT, PET, Hybrid imaging.

9. Beam Modification Techniques for Photon Beams
Effects on dose distribution - Methods of compensation for patient contour variation and/or tissue inhomogeneity. Shielding of dose-limiting tissues. Wedge filters and their use. Dynamic wedges, bolus, build-up material, compensating filters, multileaf collimators (MLC) – different designs of MLCs – Acceptance testing and QA for MLCs.

10. Treatment Planning and Advances in Radiotherapy Delivery
Patient positioning and Immobilization methods – lasers - Computerized Treatment planning systems – 2D and 3 D treatments planning – commissioning – data acquisition – quality assurance –networking in Radiotherapy – DICOM Format – DICOM RT – Radiation Oncology information management system.
Advanced Treatment techniques & calculations: 3D Conformal Radiotherapy (3D CRT) – dose calculation algorithms – Model-Based Algorithms - Dose Calculation in Homogeneous Media - Superposition and Convolution Algorithms -Pencil Beam and Path length Scaling - Collapsed Cone and Kernel Tilting – Monte Carlo calculations - IMRT optimization techniques – Plan Evaluation techniques and parameters for plan evaluation.
Treatment verification Methods : Portal films – portal imaging – Electronic portal imaging devices (EPID) – type of EPIDs, IGRT - 2D Image guided radiotherapy, 3D image guided radiotherapy, kV cone beam CT, MV Cone beam CT and other IGRT techniques

11. Electron Beam Therapy
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.

12. Radioactive Sources 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.

13. Brachytherapy

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, 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.

14. Special Procedures:

Total Body Irradiation- patient positioning, dosimetry for commissioning, in-vivo dosimetry protocol, Total skin electron irradiation- patient positioning and dosimetry, Stereotactic Radiotherapy and Radiosurgery – Methods, dosimetry, treatment planning and quality assurance. Other Radiosurgery systems - CyberKnife Radiosurgery, Novalis. Tomotherapy, Helical Tomotherapy and Rapid arc, Proton therapy - rationale, techniques, Boron Neutron Capture therapy, Photodynamic therapy – Monoclonal antibodies.

15. Quality assurance:

Periodic Quality assurances of – Telecobalt unit - Linear accelerator – MLC – EPID – OBI – Treatment planning system – Stereotactic Radiosurgery – Stereotactic Radiotherapy – IMRT – patient specific QA of IMRT – QA of special procedures – Rapid Arc – Cyber knife - Tomotherapy

Recommended Books:

1. The physics of radiation therapy: F. M. Kahn; Williams and Williams, Baltimore.
2. Introduction to radiological physics and radiation dosimetry: P.H. Attix; Wiley, New York.
3. The physics of radiology (Fourth Edition.): H.E. Johns and J.R. Cunningham; Charles C. Thomas, Springfield Ill.
4. Modern technology of radiation oncology: J. Van Dyk (Editor); Medical Physics Publishing, Madison Wisconsin.
5. Radiation physics for medical Physics: E.B. Podgorsak; Springer, New York.

6. Radiation oncology physics: a handbook for teachers and students: E.B. Podgorsak (Editor); IAEA, Vienna.
7. Radiobiology for the radiobiologist: E.J. Hall; Lippincott Williams & Wilkins, New York.

8. ICRU Reports with sections relevant to the syllabus, in particular:

i. No.24 Determination of Absorbed Doses in a Patient Irradiated by Beams of X or Gamma Rays in Radiotherapy Procedures (1976)

ii. No.38 Dose and Volume Specification for Reporting Intracavity Therapy in Gynecology (1985)

iii. No.42 Use of Computers in External Beam Radiotherapy Procedures with High-Energy Photons and Electrons (1987)

iv. No.50 Prescribing, Recording and Reporting Photon Beam Therapy (1993)

v. No.51 Quantities and Units in Radiation Protection Dosimetry (1993)

vi. No.58 Dose and Volume Specifications for Reporting Interstitial Therapy (1997)

vii. No.60 Fundamental Quantities and Units for Ionizing Radiation (1998)
viii. No.62 Prescribing, Recording and Reporting Photon Beam Therapy
ix. [Supplement to ICRU report 50] (1999)