

POSTGRADUATE INSTITUTE OF MEDICINE
UNIVERSITY OF COLOMBO

MD (CLINICAL ONCOLOGY) PART I EXAMINATION – NOVEMBER 2023

Date:- 06th November 2023

Time:- 2.00 p.m. – 4.15 p.m.

PAPER I

If the examiners cannot read your writing, they will be unable to give you full credit for your knowledge.

PHYSICS

Answer all questions.

Each question carries 100 marks.

Each question to be answered in separate book.

1.

- 1.1. (a) Define the term “Effective Dose” and briefly explain importance of Effective Dose in Radiation Protection. (20 marks)
- (b) List Effective dose limits recommended for radiation workers and female radiation workers when they become pregnant. (20 marks)
- 1.2. (a) What is the name of the Sri Lanka law governing the control of the use of ionizing radiation? (10 marks)
- (b) What are the licence periods recommended for tele gamma facility and medical linear accelerator facility by the Atomic Energy (Licence) Rule No. 1 of 2015 promulgated under the above legislation? (10 marks)
- 1.3. (a) What is meant by very short lived radioactive wastes? (10 marks)
- (b) List three basic methods of radioactive waste management. (10 marks)
- (c) Briefly discuss wastes generated in iodine therapy and radiation protection advice given to the patients at the time of release. (20 marks)

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2.

2.1. Define the following terms with reference to ICRU report 50

(a) Planning Target Volume (PTV) (15 marks)

(b) Treated Volume (TV) (15 marks)

2.2. Comment on the dose coverage between PTV and TV for a good radiotherapy plan. (10 marks)

2.3. Give two reasons each for the following variations in external beam therapy

(a) Intra- fractional (10 marks)

(b) Inter- fractional (10 marks)

2.4. Briefly explain the following radiation delivery methods in modern radiotherapy

(a) Volumetric Modulated Arc Therapy (VMAT) (15 marks)

(b) Stereotactic Body Radiotherapy (SBRT) (15 marks)

2.5. Give one advantage and one disadvantage of

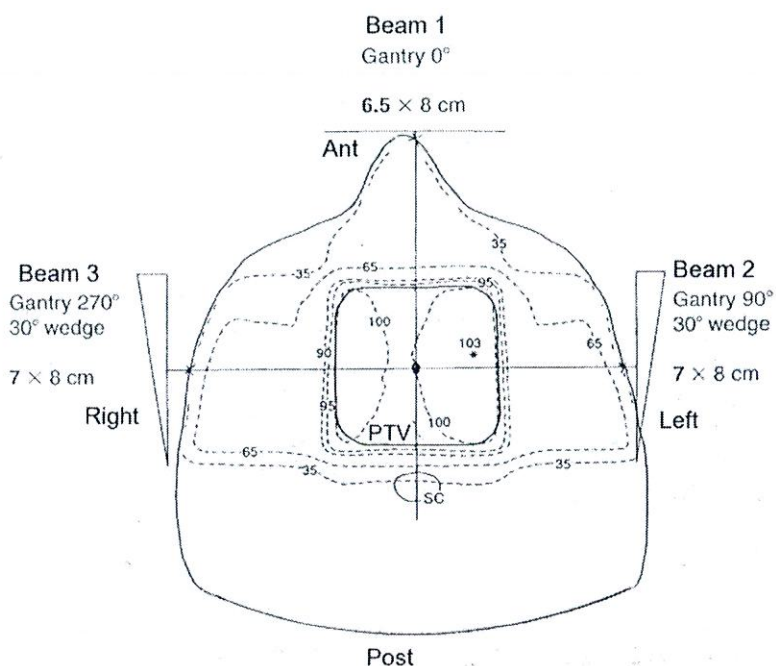
(a) VMAT (5 marks)

(b) SBRT (5 marks)

3.

3.1. Define tissue maximum ratio (TMR) in radiotherapy. (15 marks)

3.2. A nasopharyngeal tumour is planned to deliver a dose of 66 Gy to the PTV in 33 fractions over 6½ weeks using 6 MV photons from a Linear Accelerator at 100 cm SAD in the supine position with a three field technique as shown in the figure below.



Machine calibration condition:

Reference depth of ionization chamber at 1.5 cm depth in water at 100 cm source chamber distance (SCD). Dose rate is 1 cGy/MU for 10 cm x 10 cm field size.

Description	Beam 1 (Ant)	Beam 2 (Left)	Beam 3 (Right)
Gantry angle	0°	90°	270°
Treatment field size (cm ²)	6.5 x 8	7 x 8	7 x 8
Tissue depth to beam isocenter (cm)	8.0	7.0	7.0
Tissue maximum ratio (TMR)	0.822	0.854	0.854
Wedge transmission factor (30°)	-	0.640	0.640
Collimator scatter factor	0.980	0.984	0.984
Phantom scatter factor	0.970	0.972	0.972

- Find the dose rate in water at the points of dose maximum for open and wedge beams. (15 marks)
- Assuming 2D manual planning and considering equal dose to the center of PTV from each beam, calculate the number of monitor units (MUs) per field per fraction. (30 marks)
- Is the total radiation dose to spinal cord acceptable? Give reasons for your answer. (10 marks)
- How do you confirm the radiation safety of the eyes from this treatment? (15 marks)
- Briefly describe the differences when the above patient is planned with a CT based computerized system. (15 marks)

4.

4.1. Briefly describe the main function of the following components in a Linear Accelerator when the machine is functioning in high energy X ray generation mode

- (a) Magnetron (10 marks)
- (b) Flattening filter (10 marks)
- (c) Multileaf collimators (10 marks)

4.2. Sketch a diagram of a labelled thimble ionization chamber which is used for calibration of MV photon beams. (10 marks)

4.3. Explain the working principle of a thimble ionization chamber (20 marks)

4.4. Define the following terms in radiotherapy

- (a) Wedge angle (10 marks)
- (b) Wedge transmission factor (10 marks)

4.5. Give the advantages of a dynamic wedge compared to a physical wedge. (20 marks)

5.

5.1. Draw the central axis depth dose curves on the same graph, measured in water at 100 cm SSD, for:

- (a). 6 MV photon beam, 10 cm x 10 cm at 100 cm (indicate the build up region and surface dose) (15 marks)
- (b). 6 MeV electron beam with 10 cm x 10 cm applicator (indicate the therapeutic range and practical range) (15 marks)

5.2. Describe the effect on surface dose and percentage depth dose in electron beam therapy when the following parameters are increased.

- (a) Beam energy (10 marks)
- (b) Field size (10 marks)
- (c) SSD (source surface distance) (10 marks)

- 5.3. Briefly explain how photon contamination occurs in an electron beam and include the magnitude of its effect on patient dose. (15 marks)
- 5.4. A nearly circular superficial tumour with a diameter of 7 cm and maximum depth from skin of 2.5 cm has been planned to treat using electrons from a Linear accelerator.
- (a) Estimate the most appropriate electron beam energy. Justify your answer. (15 marks)
- (b) What is the size of electron applicator you would use and the diameter of the shielding cutout? (10 marks)
- 6.
- 6.1. State the dose rates for LDR, MDR and HDR after-loading brachytherapy systems. (15 marks)
- 6.2. Name two radionuclides used in HDR remote after-loading brachytherapy and give their physical characteristics. (20 marks)
- 6.3. A patient with cervical cancer is planned to treat with an HDR remote after loading brachytherapy system.
- (a) Sketch a diagram to show the shape of 100% dose line on AP view and lateral view. (10 marks)
- (b) Briefly describe how the dose coverage and optimization process is achieved by a single HDR source. (15 marks)
- (c) What is the method used for rectal dose reduction? (10 marks)
- 6.4. Name the radiation safety and protection devices that should be available when operating the HDR Brachytherapy system. (15 marks)
- 6.5. List three advantages of remote after-loading brachytherapy when compared to manual after-loading brachytherapy. (15 marks)