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POSTGRADUATE INSTITUTE OF MEDICINE
UNIVERSITY OF COLOMBO

MD (CLINICAL ONCOLOGY) PART I EXAMINATION – OCTOBER 2022

Date:- 10th October 2022 **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

Each question carries 100 marks.

Each question to be answered in a separate book.

Question one (01) is compulsory.

Answer five (05) questions of the six (06) questions from 2 to 7.

1.

1.1 (a) Define the term "Equivalent Dose" and briefly explain why biological damage to a tissue from ionizing radiation cannot be expressed in Gray (Gy). (20 marks)

(b) Access control is applied as a requirement for a "controlled area". List three other administrative and technical requirements applicable in a "controlled area". (15 marks)

1.2 (a) Briefly explain stochastic and deterministic effects giving two examples for each effect. (30 marks)

(b) What is meant by "Workload "of a Teletherapy machine and explain other information required for computation of shielding for a therapy bunker. (20 marks)

(c) What is the most appropriate shielding material for the following radiations with respect to radiation therapy rooms? (15 marks)

(i) Low energy Gamma and X-rays:

(ii) High energy (>500keV) Gamma and X-rays:

(iii) Electrons:

Contd/….2

2.

2.1 Name two interaction processes that occur in tissue with X rays for each energy;

(a) Diagnostic range (10 marks)

(b) Therapeutic range (10 marks)

2.2 With the aid of a diagram, briefly explain the main physical interaction process in tissue with 6 MV photons. (15 marks)

2.3 Why is the x-ray image from a diagnostic x-ray machine better in contrast than a Linear Accelerator image? (15 marks)

2.4 Define the term "Half Value Layer" and express the relationship to linear attenuation coefficient of the medium. (20 marks)

2.5 Explain the reasons for using

(a) Aluminium filters in a diagnostic x-ray machine. (15 marks)

(b) Beam flattening filter in a medical linear accelerator. (15 marks)

3.

3.1 Explain the following terms with reference to ICRU report 62

(a) Organ at risk (OAR) (10 marks)

(b) Planning Organ at risk volume (PRV) (10 marks)

3.2 Explain the skin sparing effect in external beam radiotherapy and give typical percentage doses delivered to the skin surface from a direct beam for ^{60}Co, 6 MV and 15 MV photons. (20 marks)

3.3 What is the aim of electronic portal imaging in 3D CRT? (10 marks)

3.4 A lady was planned for 50 Gy in 25 fractions with 3D CRT technique to treat a cervical cancer and a 7 mm set up margin was used.

A cone beam CT verification was scheduled for first 3 fractions and afterwards once a week. The following deviations were observed in the first three days:

Day 1	
X	-0.5 cm
Y	+0.3 cm
Z	+0.6 cm

Day 2	
X	-0.6 cm
Y	-0.4 cm
Z	-0.4 cm

Day 3	
X	-0.7 cm
Y	- 0.2 cm
Z	-0.2 cm

Contd/…..3

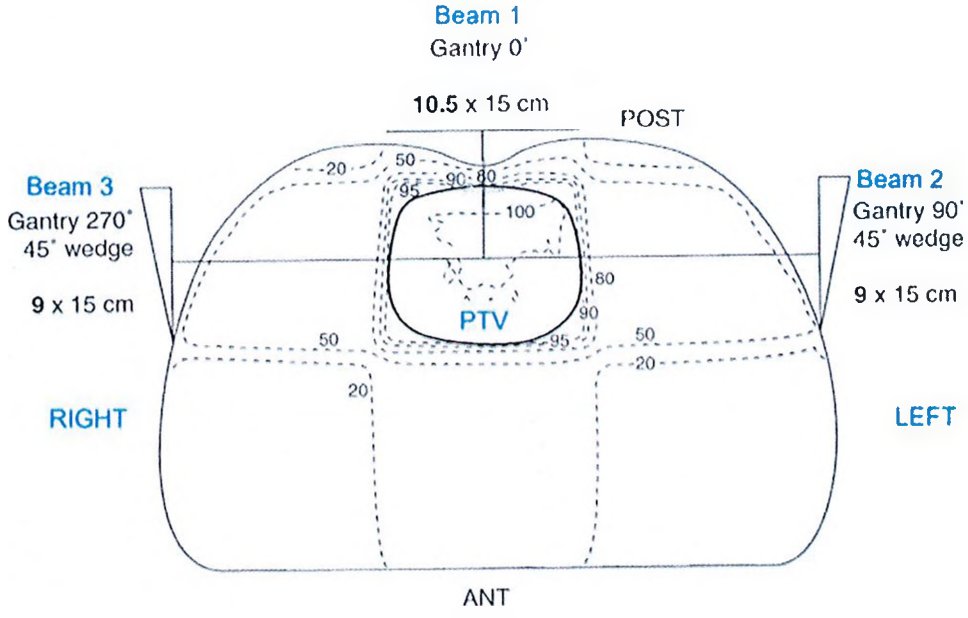
(a) What would you advise on day 1? (10 marks)

(b) Calculate the systematic component of the set-up error? (15 marks)

(c) If she was planned for Image Guided IMRT (IGRT) with daily cone beam CT imaging, would your advice on Day 1 be different? Justify the reasons. (15 marks)

(d) Mention one adaptive radiotherapy technique used to address the intra-fraction target motion? (10 marks)

4. An operable carcinoma of rectum is planned to be treated in the prone position at 100 cm SAD technique using 10 MV photon beams from a Linear Accelerator machine as shown in the figure below. The prescribed dose to the centre of the PTV is 50.4 Gy in 28 fractions over 5½ weeks.



4.1 Is the above dose distribution satisfactory according to the target dose uniformity of ICRU report 50? Justify your answer. (15 marks)

4.2 Machine calibration conditions;
Source chamber distance = 100 cm
Reference depth of calibration = 2.5 cm depth in water
Reference field size = 10 cm x 10 cm
Dose rate = 1 cGy/MU

Contd/.....4

Description	Beam 1	Beam 2	Beam 3
Tissue depth to beam isocenter (cm)	7.0	15.0	14.5
Gantry angle	0°	90°	270°
Treatment field size (cm^2)	10.5 x 15	9W x 15	9W x 15
Tissue maximum ratio	0.916	0.724	0.732
Wedge transmission factor (45°)	-	0.612	0.612
Collimator scatter factor	1.012	1.004	1.004
Phantom scatter factor	1.016	1.008	1.008

(a) Find the dose rate in water at d_{max} for open and wedge beams. (15 marks)

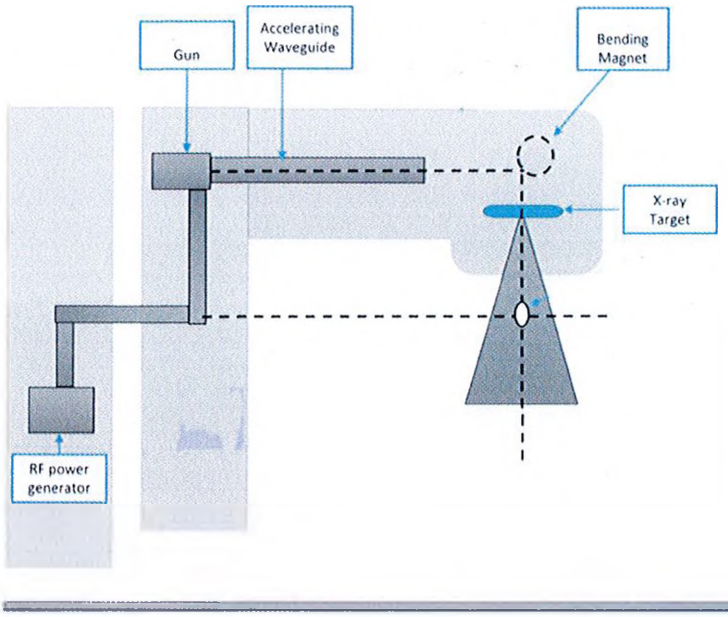
(b) Assuming 2D manual planning and considering equal dose to the centre of PTV from each beam, calculate the number of monitor units (MUs) per field per fraction. (30 marks)

4.3 Suggest two different field arrangements to be considered for above patient treatment. (20 marks)

4.4 Give two OARs take into account in this plan. (10 marks)

4.5 How could the dose to each of these be minimised? (10 marks)

5. The following diagram shows the main components of a Linear Accelerator machine.



Contd/.....5

5.1 Briefly explain the function of the components labeled in the diagram. (50 marks)

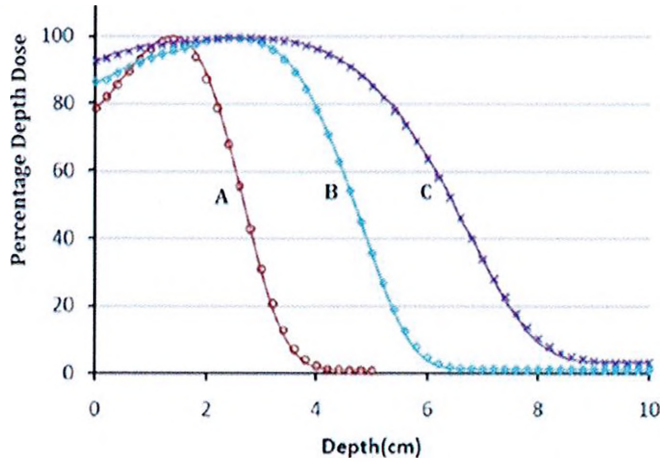
5.2 What is the role of the dual ionization chambers embedded in the head of linear accelerator? (20 marks)

5.3 Explain the purpose of the scattering foil in a linear accelerator. (10 marks)

5.4 List four (04) quality control checks with their tolerance, performed daily of a linear accelerator. (20 marks)

6.

6.1 The following PDD graph was obtained in water on the central axis at 100 cm SSD, for three electron energies with applicator 10cm x 10cm. Identify A, B and C electron beam energies and justify your answer. (30 marks)



6.2 Give reasons for the bremsstrahlung tail and explain the dependence of it on beam energy. (20 marks)

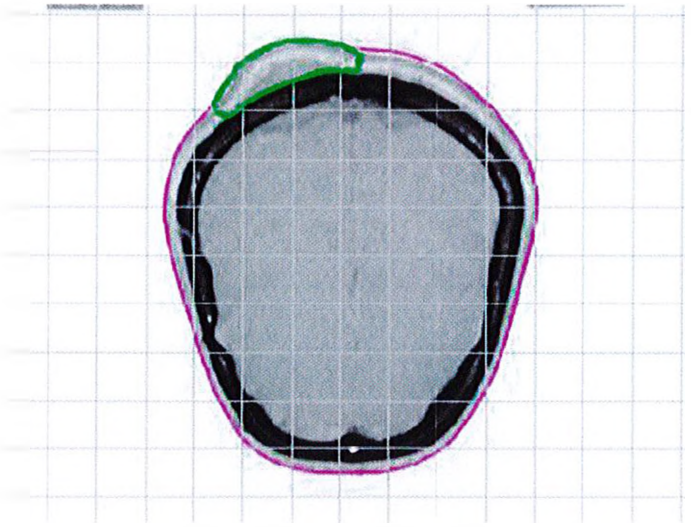
6.3 Explain with the aid of a diagram why the electron beam needs to be perpendicular to the lesion to be treated as far as possible. (15 marks)

6.4 Electron applicators with or without special cutouts are used for field shaping in electron beams. Explain why? (15 marks)

6.5 What is the standard thickness of a Cerrobend electron cutout? (05 marks)

6.6 A gentleman is planned to treat a scalp tumour using electrons. The PTV is marked in the figure below and the PTV size is 6 cm × 3.5 cm × 1 cm. Indicate the most suitable electron energy, applicator size and the cutout size that you would select? (15 marks)

Contd/.....6



7.

7.1 Name a radionuclide each with its half-life used for temporary implant and permanent implant brachytherapy. (16 marks)

7.2 Write down the single plane implant rules of Paris system for interstitial brachytherapy. (15 marks)

7.3 Briefly explain how the average basal dose rate is determined for four parallel lines in a single plane interstitial brachytherapy. (14 marks)

7.4 Illustrate the reason for the steeper dose fall off in Brachytherapy compared to External Beam Therapy? (15 marks)

7.5 Cervical cancer is treated with intra-cavitary brachytherapy using a tandem and a pair of ovoids. The dose is prescribed to point A.

(a) Define point A (10 marks)

(b) List 2 main disadvantages in using point A based prescription. (20 marks)

(c) What is the modern alternative to using Point A (10 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – OCTOBER 2022

Date:- 10th October 2022 **Time:-** 4.30 p.m. – 5.15 p.m.

PAPER I

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

MEDICAL STATISTICS

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1. A study was conducted to determine the diagnostic accuracy of dermoscopy for melanoma in adults. The results are given in below Table 1.

Table 1. Accuracy of dermoscopy in the detection of melanoma in adults.

DETECTION METHOD	SENSITIVITY %	SPECIFICITY %	POSITIVE LIKELIHOOD RATIO	NEGATIVE LIKELIHOOD RATIO
Visual inspection alone (in person)	76	75	3.04	0.32
Dermoscopy with visual inspection (in person)	92	95	18	0.08

1.1. Briefly explain the methodology of the above study. (20 marks)

1.2. Define sensitivity and specificity. (20 marks)

1.3. Define positive likelihood ratio of 18. (20 marks)

1.4. Briefly explain a method of reducing risk of bias of the above study. (20 marks)

1.5. What is the conclusion of the above study? (20 marks)

Contd...../2-

2. A study was conducted to examine trends in incidence of breast cancer in a country. The investigators had found that the age standardized incidence of female breast cancer appears to have increased from 17.3 per 100,000 in 2001 (95% confidence interval [95% CI] 16.5–18.2) to 24.7 per 100,000 in 2010 (95% CI 23.7–25.7).

2.1. Define

2.1.1. incidence (15 marks)

2.1.2. incidence density (15 marks)

2.2. Briefly explain the methods of calculating age standardized incidence. (30 marks)

2.3. Interpret 95% confidence interval for an age standardized cancer incidence. (20 marks)

2.4. What is the conclusion of the above study? (20 marks)

Contd...../3-

3. A systematic review was conducted to determine effectiveness of Hysterectomy (radical) with neoadjuvant chemotherapy versus with chemoradiotherapy alone for women with locally advanced cervical cancer (LACC). The results are given in below in Table 2.

Table 2 Hysterectomy (radical) with neoadjuvant chemotherapy versus with chemoradiotherapy alone for women with locally advanced cervical cancer

Outcomes	**Relative effect (95% CI)**	**No. of participants (studies)**	**Certainty of the evidence (GRADE)**	**Comments**
Overall survival Median follow-up 58.5–98.4 months	**HR 0.94** (0.76 to 1.16)	1253 (2 RCTs)	⨁⨁⨁⨀ **Moderate**	$I^2 = 0\%$

HR: Hazard Ratio, CI: Confidence Interval, RCT: Randomized Controlled Trial

3.1. Briefly explain the methodology of the above review. (25 marks)

3.2. Briefly explain the method of assessing risk of bias. (25 marks)

3.3. Comment on each of the following in Table 2:

3.3.1. Median follow up (5 marks)

3.3.2. Relative effect (10 marks)

3.3.3. No of studies (5 marks)

3.3.4. Certainty of the evidence (15 marks)

3.3.5. $I^2 = 0$ (15 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – OCTOBER 2022

Date:- 11th October 2022 **Time:-** 12.00 p.m.– 12.45 p.m.

PAPER II

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

CANCER BIOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1.

1.1. List the six (06) hallmarks of cancer which were initially described. (12 marks)

1.2. Briefly describe the reprogramming of energy metabolism in cancer cells. (28 marks)

1.3. Justify the statement "*TP53* (P 53) is the last gate keeper of the genome". (15 marks)

1.4. List three (03) factors that are known to activate *TP53* gene expression. (15 marks)

1.5. Outline the changes to the TP53 protein that will be expected in a) missense mutation and b) nonsense mutation giving reasons. (30 marks)

Contd...../2-

2.

2.1. Briefly describe

2.1.1. why autophagy can lead to recurrence of cancer. (20 marks)

2.1.2. how necrosis differs from apoptosis. (15 marks)

2.2.

2.2.1. List two (02) major differences in pedigrees of *BRCA1* and *BRCA2* mutation carriers. (10 marks)

2.2.2. Name the test/s that can be carried out to detect and confirm *BRCA1/BRCA2* mutations. (5 marks)

2.2.3. Name the sample that should be tested to find a) germ line mutations b) somatic mutations. (10 marks)

2.2.4. Name four genes other than *BRCA1* and *BRCA2* associated with hereditary breast and ovarian cancer syndrome. (10 marks)

2.2.5. Briefly describe the main differences in DNA repair carried out by BRCA1 and BRCA2 proteins; and mis-match repair proteins. (30 marks)

3.

3.1. What is tumour immunotherapy? (10 marks)

3.2. Describe one (01) advantage of immunotherapy compared to conventional therapy. (10 marks)

3.3. List five (05) strategies used in tumour immunotherapy (including experimental) with one (01) example each. (20 marks)

3.4. Briefly describe the structure of CAR T cells. (20 marks)

3.5. List four (04) side effects of CAR T cell therapy. (20 marks)

3.6. Describe one (01) side effect, mentioned in 3.5. (20 marks)

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Date:- 11th October 2022 **Time:-** 11.00 a.m. – 11.45 a.m.

PAPER II

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PHARMACOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1.

1.1. Describe the steps in the original WHO analgesic ladder. (15 marks)

1.2. Explain the clinical usefulness of using WHO analgesic ladder in cancer pain management. (15 marks)

1.3. Describe the pharmacokinetics of morphine following oral administration. (30 marks)

1.4. List four (04) methods to minimize the adverse effects of morphine. (20 marks)

1.5. Explain the significance of pharmacogenetics in relation to use of codeine as an analgesic in pain management. (20 marks)

Contd...../2-

2.

2.1. Explain the mechanism of action of docetaxel in the treatment of prostate cancer (20 marks)

2.2. Explain the pharmacological basis for the use of anastrozole in the treatment of breast cancer. (20 marks)

2.3. Explain the mechanism of action of trastuzumab in the treatment of certain cancers. (20 marks)

2.4. Discuss the basis of adjuvant chemotherapy in treatment of cancers. (20 marks)

2.5. Explain the benefits of using colony stimulating factors in the setting of chemotherapy for cancer. (20 marks)

3.

3.1. A newly developed anti-cancer medicine is recommended for oral route of administration. Discuss five (05) factors that influence the concentration of this medicine in the systemic circulation when given orally (25 marks)

3.2. Define plasma-elimination half-life (10 marks)

3.3. List five (05) factors that determine the plasma-elimination half-life. (10 marks)

3.4. Explain first order and zero order kinetics (10 marks)

3.5. List five (05) clinical relevance of plasma-elimination half-life and type of kinetics (first /zero order) with regard to anti-cancer medicines. (15 marks)

3.6. List the types of pharmacokinetic drug-drug interactions with respect to anti-cancer medicines (15 marks)

3.7. Give three (03) examples with their consequences of a pharmacokinetic drug-drug interaction. (15 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – OCTOBER 2022

Date:- 11th October 2022 **Time:-** 10.00 a.m. – 10.45 a.m.

PAPER II

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RADIOBIOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1.

1.1. Differentiate between direct and indirect actions of ionizing radiation on DNA. (20 marks)

1.2. Elucidate the basis of the two DNA double strand break repair mechanisms available in cells. (20 marks)

1.3. Compare showing a cell survival curve mitotic and apoptotic cell death. (20 marks)

1.4.

1.4.1. A tumour consists of 10^7 clonogenic cells. The effective dose response curve, given in daily dose fractions of 2 Gy, has no shoulder and a D_0 = 3 Gy. What total dose is required to give a 90% chance of tumour cure? (20 marks)

1.4.2. If the clonogenic cells in 1.4.1. underwent three cell doublings during treatment, what approximate total dose would be required to achieve the same probability of tumour cure? (20 marks)

Contd ...../2-

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – OCTOBER 2022

Date:- 11th October 2022 **Time:-** 9.00 a.m. – 9.45 a.m.

PAPER II

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

PATHOLOGY

Each question carries 100 marks.
Each question to be answered in a separate book.
Answer TWO (02) questions of the THREE (03) questions given below.

1. A 30-year-old woman presented with a solitary thyroid nodule. US guided fine needle aspirate (FNAC) revealed a Bethesda category IV lesion.

1.1. List the categories in the 2017 Bethesda classification of thyroid cytopathology and management options for each category. (60 marks)

1.2. List two (02) possible lesions which can give the above thyroid cytology in this patient. (20 marks)

1.3. List two (02) important histological features important in differentiating these two lesions and describe how the pathologist assesses these two features. (20 marks)

2. A 15-year-old girl presented with abdominal pain and US scan revealed a left adnexal mass with ascites.

2.1. List three (03) serum markers you would perform in this patient prior to surgery. (15 marks)

2.2. List four (04) primary malignant ovarian tumours you would expect to see in this patient. (20 marks)

2.3. Name five (05) immunohistochemical markers that can be utilized to help the pathologist with diagnosis. (25 marks)

2.4. Briefly outline current FIGO staging of ovarian tumours. (40 marks)

Contd……./2-

3. An 18-year-old boy presents with a mediastinal mass.

3.1. List five (05) haemato-lymphoid neoplasms you will consider in your differential diagnosis. (20 marks)

3.2. Briefly discuss how immunohistochemical markers would help in the final diagnosis of the 5 haemato-lymphoid neoplasms mentioned above. (50 marks)

3.3. Give two (02) other ancillary laboratory tests, explaining how they would help in the diagnosis. (10 marks)

3.4. Mention five (05) non haemato-lymphoid neoplasms that can arise in the mediastinum. (20 marks)