POSTGRADUATE INSTITUTE OF MEDICINE
UNIVERSITY OF COLOMBO

MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2019

Date:- 26th August 2019 **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. Write units for the following quantities used in Radiation Protection

(a) Exposure

(b) Dose

(c) Equivalent Dose

(d) Effective dose

(e) Collective Dose (20 marks)

1.2.

(a) What is the name of Sri Lanka basic law governing the control of use of ionizing radiation. (10 marks)

(b) What are the license periods recommended for a telegamma facility and a medical linear accelerator facility by the Atomic Energy (license) Rule No. 1 of 2015 promulgated under the above legislation. (10 marks)

1.3. Briefly explain stochastic and deterministic effects giving two (02) examples for each effect. (20 marks)

Contd...../2-

1.4.

(a) The regulatory authority of Sri Lanka has declared that 2015-2019 is the five-year block for decision on regulatory dose limits. A worker at a radiotherapy facility has been exposed to 25 mSv in 2015 and 20 mSv in 2018 and 48 mSv in 2019 and no exposure was recorded in 2016 and 2017.
Discuss this above exposure with respect to dose limitation principles. (20 marks)

(b) What are the two (02) quantities recommended to be measured in Sri Lanka using TLDs to measure personal external dose and three (03) advantages of using LiF as a dosimeter? (20 marks)

2.

2.1. Briefly explain the main interaction process which transfers the energy of ionizing radiation to tissue from a diagnostic x-ray machine. (20 marks)

2.2. Sketch the energy spectrum of photons from an x-ray tube with a Tungsten target operated at 80 kV potential. (20 marks)

2.3. How are low energy photons removed from the above x-ray beam? (15 marks)

2.4. How is the beam quality index specified and measured for kV and MV x-ray photons. (30 marks)

2.5. Image quality is better with kV x-rays than MV x-rays. Explain why? (15 marks)

3.

3.1. Define the following terms in relation to ICRU (International Commission on Radiological Units and Measurements) 50 and 62 reports.

(a) Internal Margin (IM) (15 marks)

(b) Internal Target Volume (ITV) (15 marks)

3.2. Briefly explain with two (02) examples for each, the following terms in external beam radiotherapy

(a) intra-fractional variations (20 marks)

(b) inter-fractional variations (20 marks)

Contd...../3-

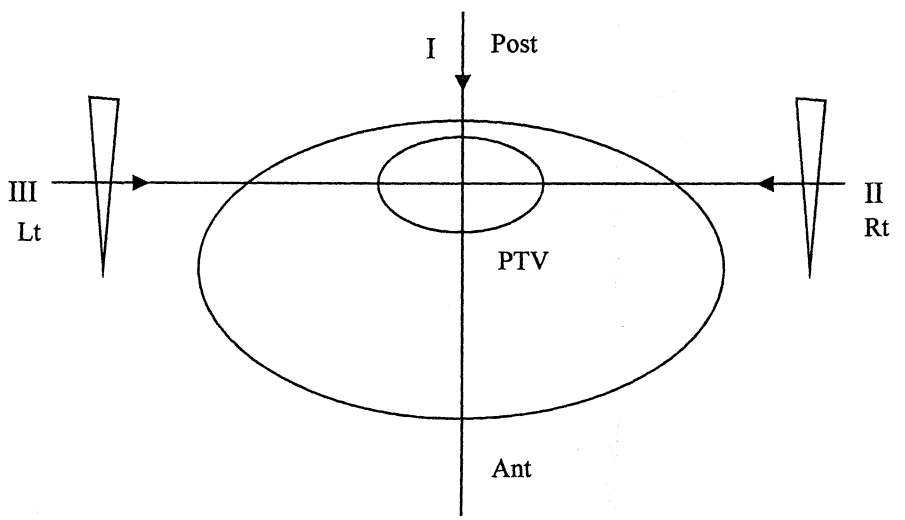
3.3. Explain how the delivery of IMRT differs from 3D CRT. (20 marks)

3.4. List one (01) advantage and one (01) disadvantage of using IMRT compared to 3D CRT. (10 marks)

4.

4.1 Define Tissue Maximum Ratio (TMR) in external beam radiotherapy. (10 marks)

4.2 Post operative carcinoma of rectum is to be treated in the prone position using 10MV photon beam from a Linear Accelerator machine at 100 cm SAD (Source Axis Distance) as shown in the figure below. The prescribed dose to the center of PTV is 50.4 Gy in 28 fractions over 6 weeks and the relevant beam data is given below.



Machine calibration conditions:

Source chamber distance = 100 cm
Calibration reference depth (d_{max}) = 2.5 cm in water,
Reference field size = 10 x 10 cm^2
Calibration dose rate = 1 cGy/MU

Contd...../4-

Description	Beam I	Beam II	Beam III
Tissue depth to beam isocenter (cm)	7	16	17
Gantry angle	0°	90°	270°
Treatment field size (cm^2)	11 x 14	10w x 14	10w x 14
Tissue maximum ratio	0.917	0.708	0.688
Wedge transmission factor (30°)	-	0.622	0.622
Collimator scatter factor	1.014	1.012	1.012
Phantom scatter factor	1.020	1.018	1.018

w indicates wedged beam width

(a) Using the above data, calculate the dose rate at d_{max} in water for open beam and wedge beams. (20 marks)

(b) Assuming equal dose to the center of PTV from all beams, calculate the number of monitor units (MUs) per field per fraction. (20 marks)

4.3. Where do you expect hot spots outside the PTV in the above plan and give two (02) simple methods to reduce those hot spots, keeping same gantry angles. (20 marks)

4.4. Illustrate two (02) additional field arrangements to treat the above mentioned patient. (20 marks)

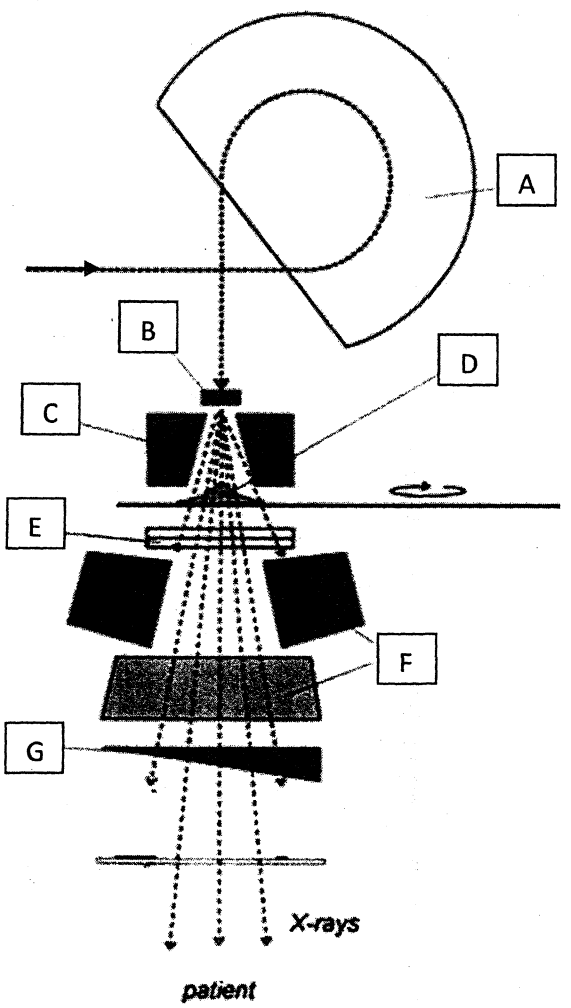
4.5. Why are the number of MUs of each field slightly different for manual and CT based computerized treatment planning? (10 marks)

Contd..../5-

5.

5.1. Briefly explain how electrons are accelerated in a linear accelerator. (15 marks)

5.2. The following diagram shows the head of a Linear Accelerator machine. Identify the components A to G and briefly explain the function of each component. (70 marks)



5.3. List three (03) quality control checks with their tolerance performed daily of a Linear Accelerator. (15 marks)

Contd...../6-

6.

6.1. Draw the central axis percentage depth dose curve for a 9 MeV electron beam incident perpendicularly on a water phantom at 100 cm SSD for15 x 15 cm^2 field. Indicate the typical values of dosimetry parameters R_{100}, R_{90}, R_{50} and R_p (25 marks)

6.2. State whether each of the above dosimetry parameters will increase or decrease if the incident beam is 30° angled from the central axis? (20 marks)

6.3. How is R_p used in electron therapy planning? (15 marks)

6.4. State two (02) situations where electron field matching may require. (20 marks)

6.5. Explain the problems associated with junctioning two electron beams. (20 marks)

7.

7.1. Complete the following table for radioactive sources commonly used in Brachytherapy. (a separate table is given with answer sheet) (24 marks)

Radionuclide	Types of radiation emitted	Average energy (MeV)	Half life	Half value layer thickness
^{192}Ir				
^{60}Co				
^{125}I				

7.2. Give one (01) disadvantage of ^{226}Ra in Brachytherapy (06 marks)

7.3. What is meant by manual after loading and remote after loading in brachytherapy? Give one (01) example for each. (20 marks)

7.4. Give the rules for arrangement of radioactive sources for planner implants in Paris system. (20 marks)

7.5. Using a diagram explain Basal point locations and Basal dose rate for the two plane implant with a triangular arrangement of five wires. (20 marks)

7.6. How is reference dose rate related to Basal dose rate in Paris system? (10 marks)

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Date:- 26th August 2019 **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 cancer incidence among persons living with HIV (PLWH) using cancer and death registry data. The cancer incidence among the PLWH was 560.8 (95% confidence interval :419.5 to 735.4) per 100 000 person years. Age-adjusted standardized incidence ratio (SIR) was 2.0 (95% confidence interval 1.5 to 2.6) relative to the general population.

1.1. What was the study design? (10 marks)

1.2. What is the advantage of knowing incidence density over cumulative incidence? (10 marks)

1.3. Explain how you would calculate person years. (20 marks)

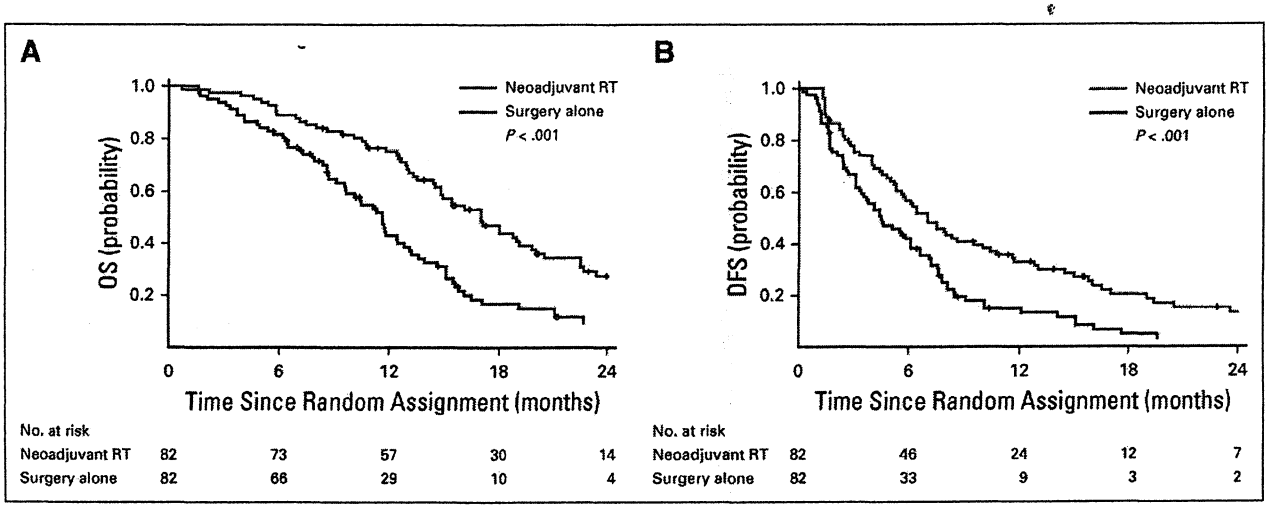
1.4. Interpret the 95% confidence interval of the cancer incidence. (20 marks)

1.5. Explain how you would calculate SIR. (20 marks)

1.6. What are the differences between direct and indirect standardization? (20 marks)

Contd...../2-

2. A randomized controlled trial was conducted in patients with resectable hepatocellular carcinoma (HCC). Patients were randomly assigned to receive neoadjuvant three-dimensional conformal radiotherapy (RT) followed by hepatectomy (n = 82) or hepatectomy alone (n = 82). The primary end point was overall survival. The median follow-up was 15.2 months (interquartile range, 10.5-21.5 months) in the neoadjuvant RT group and 10.8 months (interquartile range, 6.8-15.6 months) in the surgery-alone group.



2.1. Briefly describe the method of randomization. (20 marks)

2.2. What do you mean by 'primary end point'? (10 marks)

2.3. State the reason for giving median follow up and interquartile range. (10 marks)

2.4. On the graph provided

(a) What type of analysis is this? (10 marks)

(b) What is the relevance of the numbers given at the bottom of each? (10 marks)

(c) What is the difference between graph A and graph B. (10 marks)

2.5. State whether further analysis is necessary to come to a valid conclusion giving reasons. (20 marks)

2.6. What is the conclusion of the study? (10 marks)

Contd...../3-

3. A researcher is interested to design a study to determine whether coffee consumption is a risk of digestive cancers.

   How would you design a prospective cohort study protocol considering the following components?

   (a) Selection of study population (25 marks)

   (b) Data collection (25 marks)

   (c) Statistical data analysis (25 marks)

   (d) Minimizing bias (25 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2019

Date:- 27th August 2019 **Time:-** 9.00 a.m. – 9.45 a.m.

PAPER II

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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 50-year-old female patient presents to you with a left parotid mass and facial nerve palsy.

1.1. List four (04) possible primary salivary tumours in the differential diagnosis. (20 marks)

1.2. State two (02) important investigations you would request to make a pathological diagnosis on this patient. (10 marks)

1.3. Briefly describe microscopic features of two (02) of the lesions above. (30 marks)

1.4. List five (05) important features in the pathology report which would help you in management of this patient. (20 marks)

1.5. Describe the T stage classification for parotid tumours. (20 marks)

Contd...../2-

2. A 15-year-old boy has osteosarcoma of the left femur.

   2.1. Briefly state

   (a) clinical (15 marks)

   (b) radiological (15 marks)

   (c) microscopic features of osteosarcoma. (15 marks)

   2.2. List three (03) subtypes of osteosarcoma. (15 marks)

   2.3. Give four (04) good and four (04) bad prognostic factors associated with osteosarcoma. (40 marks)

3. A 60-year-old man with a chronic cough is found to have a central lung lesion on chest x-ray and CT scan.

   3.1. List five (05) possible malignant tumours that you would consider in the differential diagnosis. (25 marks)

   3.2. Briefly describe how immunohistochemistry would help to differentiate the tumours you have listed in 3.1 in a small biopsy of the lesion giving examples. (60 marks)

   3.3. Give three (03) reasons as to why a definitive diagnosis of the tumour type is mandatory. (15 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2019

Date:- 27th August 2019 **Time:-** 10.00 a.m. – 10.45 a.m.

PAPER II

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

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. Briefly explain the three (03) mechanisms of cell death after irradiation. (15 marks)

1.2. Name the three (03) different ways by which two double strand DNA breaks may interact and rejoin to give rise to radiation induced chromosome aberrations. (15 marks)

1.3. What would be the end result of the 3 types of aberrations listed under 1.2? (15 marks)

1.4. Give four (4) types of genes in a cell that affect its radiosensitivity. (20 marks)

1.5. Using an appropriate plot, elucidate the α/β ratio using the Linear Quadratic Model of the dose response relationship for sparsely ionizing radiation. (25 marks)

1.6. During the course of radiotherapy, a tumor containing 10^8 cells receives 35 Gy. If the $D0$ is 2.2 Gy, how many tumor cells will be left? (10 marks)

Contd...../2-

2.

2.1. Name the 6Rs that explain the rationale behind fractionation of radiotherapy. (20 marks)

Draw a diagram showing the effect of dose-rate on radiation cell survival. (10 marks)

Include:

(a) acute high dose rate (05 marks)

(b) low dose rate (05 marks)

(c) effect of redistribution (10 marks)

(d) effect of repopulation (10 marks)

2.2. Define the following:

(a) LET (10 marks)

(b) RBE (10 marks)

2.3. Draw a diagram to show the variation of biological effectiveness (RBE) of radiation with LET of approximately (20 marks)

(a) 2 keV/μm

(b) 100 keV/μm

(c) 200 keV/μm

3.

3.1. List the three (03) different syndromes that may result due to acute radiation exposure. (15 marks)

3.2. For each syndrome listed under 3.1, provide the following:

(a) approximate exposure dose (05 marks)

(b) symptoms (05 marks)

(c) mechanism of action (05 marks)

(15 x 3 = 45 marks)

3.3. What are the four principal effects of *in utero* radiation exposure? (20 marks)

3.4. List four (04) cancers which may be radiation-induced second malignancies after mediastinal radiotherapy. (20 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2019

Date:- 27th August 2019 **Time:-** 11.00 a.m. – 11.45 a.m.

PAPER II

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

CHEMOTHERAPY (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. Mrs. Perera was treated for breast cancer with multiple bone metastasis. For the pain she was initially treated with codeine and in the last hospital visit it was decided to change to oral morphine due to inadequate pain relief.

   1.1. List five (05) factors that need to be considered when deciding on the initial dose of morphine. (20 marks)

   1.2. Explain the important pharmacokinetics of morphine. (30 marks)

   1.3.

   (a) How does the metabolism of codeine defer from morphine? (15 marks)

   (b) What is the effect of genetic polymorphism on codeine metabolism? (15 marks)

   1.4. If the patient had adequate pain relief with 60 mg of oral morphine per day, calculate the equivalent subcutaneous morphine dose. (10 marks)

   1.5. Explain the reason for the difference in the dose when using above mentioned routes of administration. (10 marks)

Contd...../2-

2.

2.1. Explain briefly the mechanism of action of platinum compounds in cancer. (30 marks)

2.2. Platinum is usually given in combination with other drugs, commonly etoposide and bleomycin, for the treatment of testicular cancer. Give three (03) reasons for the use of combination therapy. (30 marks)

2.3. Explain the mechanism of action of

(a) Tamoxifen (20 marks)

(b) Zoledronic acid (20 marks)

in the treatment of breast cancer

3. There are several cellular targets for drug action in the body.

3.1. Name the four (04) main targets on which drugs act in the body. (10 marks)

3.2. Name a drug used in oncology practice that acts on each target type mentioned in 3.1 naming the target and the drug. (20 marks)

3.3. Give one (01) indication for use of each drug you named in 3.2 (20 marks)

3.4. Name the four (04) different types of drug receptors. (10 marks)

3.5. Give an example of an agonist and an antagonist acting on each type of receptor mentioned in 3.4 naming the receptor and the drugs. (40 marks)

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MD (CLINICAL ONCOLOGY) PART I EXAMINATION – AUGUST 2019

Date:- 27th August 2019 **Time:-** 12.00 noon – 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.

(a) Draw a clearly labeled diagram of the cell cycle. (10 marks)

(b) State the function of each of the cell cycle check points. (15 marks)

1.1. List four (04) factors that activate the intrinsic pathway of apoptosis. (10 marks)

1.2. Describe the role of the following in apoptosis:

(a) Caspases (30 marks)

(b) BH123 proteins (20 marks)

1.3. Describe how necrosis differs from apoptosis. (15 marks)

Contd...../2-

2.

2.1.

(a) Briefly outline the signaling pathway in response to binding of epidermal growth factor (EGF) to its receptor (EGFR). (25 marks)

(b) Some mutations in the EGF/EGFR signaling pathway render treatment with tyrosine kinase inhibitors ineffective.

(i) Name two (02) commonly mutated genes in this pathway. (10 marks)

(ii) Explain why these mutations prevent tyrosine kinase inhibitor action. (15 marks)

2.2.

2.1.1. Name the two (02) genes which are **frequently mutated** in hereditary breast and ovarian cancer syndrome. (10 marks)

2.1.2. Briefly outline how these mutations can be detected. (20 marks)

2.1.3. Explain the mechanism by which the genes mentioned in 2.2.1 lead to carcinogenesis. (20 marks)

3.

3.1. List five (05) classes of tumour antigens. (20 marks)

3.2. Describe two (02) tumour antigens mentioned above. (30 marks)

3.3. Briefly describe immunotherapy directed against one (01) of the above tumour antigens. (20 marks)

3.4. List two (02) extrinsic mechanisms of immune evasion. (10 marks)

3.5. Describe the above two extrinsic mechanisms of immune evasion. (20 marks)