UNIVERSITY OF JAFFNA, SRI LANKA

BACHELOR OF SCIENCE IN MEDICAL LABORATORY SCIENCES

SECOND YEAR FIRST SEMSTER EXAMINATION – JANUARY 2016

MLSMT 2144 MEDICAL LABORATORY TECHNOLOGY I

Date: 28.01.2016 **Time: 3 hours**

ANSWER ALL EIGHT QUESTIONS.

ANSWER PARTS A, B & C IN SEPARATE ANSWER BOOKS

PART A

1.

1.1. Explain why X-ray unit needs radiation protection only when machine is on, while Telecobalt-60 unit needs always. (20 Marks)

1.2. List the properties of a Co-60 radionuclide used in Telecobalt machine. (30 Marks)

1.3. Briefly describe the importance of immobilization devices used in Telecobalt-60 radiation treatment with two examples. (30 Marks)

1.4. Radiation output measured of a teletherapy machine at 80 cm distance from a Co-60 source was 160.0 cGy/min. Calculate the radiation output of the machine at 100 cm distance from that Co-60 source. (20 Marks)

2.

2.1. Give the name of the equipment used to treat the cancer patients by using both X-rays and electron beam. (10 Marks)

2.2. Explain how scatter radiation is produced in X-ray imaging. (20 Marks)

2.3. How scatter radiation effects could be minimized in an attenuator? (20 Marks)

2.4. Give the purposes of following components used in medical X-ray tubes.

2.4.1. Electron focusing cup

2.4.2. Tungsten anode

2.4.3 Protective housing (30 Marks)

2.5. Briefly describe the advantages of a rotating anode used in a medical X-ray tube. (20 Marks)

3.

3.1. Define "Compton effect". (20 Marks)

3.2.

3.2.1. Give the use of collimator in gamma camera. (10 Marks)

3.2.2. Explain why different types of collimators are used in a gamma camera in nuclear medicine imaging. (30 Marks)

3.3. Discuss the working principle of a free air ionization chamber in the measurement of ionizing radiation. (40 Marks)

4.

4.1. List the production methods of radionuclides. (20 Marks)

4.2. Briefly explain the method of production of a radionuclide which is related to charge particles. (30 Marks)

4.3. Explain why radionuclide Tc-99m is commonly used in the preparation of radiopharmaceuticals. (50 Marks)

PART B

5. Radiotherapy is an important cancer treatment modality either alone or in combination with chemotherapy. With the advancement of computer based radiation treatment planning and guided delivery many cancers are cured with lesser side effects to the patients.

5.1 Draw a cell cycle and indicate the phases that are radio sensitive and radio resistant. (10 Marks)

5.2 Describe the mechanism of "cancer cell kill" by ionizing radiation. (20 Marks)

5.3 List various types of fractionations used in radiotherapy. (15 Marks)

5.4 What is the radiobiological principle behind the fractionated radiotherapy? (20 Marks)

5.5 Describe the principles used in radiation protection. (20 Marks)

5.6 List the short term and long term side effects of ionizing radiation. (15 Marks)

PART C

6.

6.1. Write down the Bragg's Law. (10 Marks)

6.2. Write the expression of an inter-planer distance between two parallel planes of a cubic unit cell in terms of Millar indices (h k l) and its lattice constant. (10 Marks)

6.3. Hence, show that the following expression for a Debye- Scherrer arrangement which is used to find the crystal structure of a power of a crystalline material by using a monochromatic X-rays.

$$\frac{\sin^2\theta}{(h^2 + k^2 + l^2)} = \frac{\lambda^2}{4a^2} = \text{constant}$$

Symbols have their usual meanings. (30 Marks)

6.4. An alkali halide is studied with the Debye-Scherrer technique and Cu Kα radiation (λ = 1.540 Å). If the Bragg angles for the first five lines are 10.83°, 15.39°, 18.99°, 22.07° and 24.84°, calculate the lattice parameter. (40 Marks)

6.5. Hence, identify the Miller indices of those planes. (10 Marks)

7.

7.1 List five properties of a Laser beam. (10 Marks)

7.2. Briefly discuss the following processes that occur when the light interacts in an active medium:

(i) absorption (ii) spontaneous and (iii) stimulated emission. (30 Marks)

7.3. What is meant by population inversion of an active medium? (10 Marks)

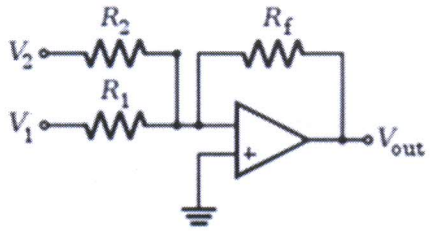
7.4. Explain briefly, how Laser light interacts with a human tissue? (10 Marks)

7.5. What is meant by photochemical and photothermal mechanisms used in cancer treatment. (20 Marks)

7.6. Explain briefly, how photodynamic therapy is used to treat cancer? (20 Marks)

8.

8.1. The following circuit has an ideal operational amplifier



8.1.1. State the properties of an ideal operational amplifier (10 Marks)

8.1.2. Derive an expression for the output V_{out} in terms of V_1, V_2, R_1 R_2 and R_f. (20 Marks)

8.1.3. If the feedback resistor R_f is 200 kΩ, estimate the values of R_1 and R_2 given that the circuit is designed deliver an output voltage $V_{out} = -5V_1 - V_2$, (20 Marks)

8.2.

8.2.1. Draw the circuit symbols and write down the truth tables of AND, OR, XOR, NAND, NOR and XNOR gates. (24 Marks)

8.2.2. Design a circuit to compare two single bits 'A' and 'B' with all possible outputs (16 Marks)

8.2.3. Redraw the above circuit using NAND gates only (10 Marks)