THE OPEN UNIVERSITY OF SRI-LANKA

B.Sc DEGREE PROGRAMME-LEVEL - 05

MEDICAL PHYSICS – PHU 3158 / PHE 5158

FINAL EXAMINATIONS - 2009/2010

DURATION: TWO AND HALF HOURS (2 ½ hrs)

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Date: 26th of June 2010   **Time: 1.30 pm – 4.00 pm**

Answer <u>FOUR QUESTIONS</u> only

Speed of light in vacuum (c) = 3×10^8 ms^{-1}
Plank's constant (h) = 6.63×10^{-34} Js
Electron charge (e) = 1.6×10^{-19} C

1. a) Briefly describe the possible types of interactions between "light" and "Matter".
                                                                                                    (15 marks)
    b) Explain with the aid of diagram, the way that the laser light is produced.
                                                                                                    (25 marks)
    c) Which properties of lasers make them useful in medicine, how and where these properties are applied?   (20marks)
    d) In which ways the population inversion of a laser medium is achieved?
                                                                                                    (10marks)
    e) State the common types of lasers with examples and give the uses and the type of operation of each.
                                                                                                    (15 marks)
    f) The spot size of the He-Ne laser is 0.39 mm and wavelength of the beam is 633 nm. What is the length of the laser cavity, which is of the confocal type?
                                                                                                    (15 marks)

2. a) Light has some interesting properties, many of which are used in medicine. State five of them.   (5 marks)
    b) Write down five uses of light in medicine.
                                                                                                    (10 marks)
    c) Define the terms "Illuminance" and "Luminance".
                                                                                                    (15 marks)
    d) Describe with the help of diagram, the principle behind how physician looks into a body opening with the use of visible light.   (25 marks)
    e) i)   Define the UV-A, UV-B and UV-C regions of ultraviolet radiation giving there respective wavelengths.   (10 marks)
        ii)   Give two beneficial and two adverse effects of UV light.
                                                                                                    (10 marks)
        iii) Describe how ultraviolet radiation is absorbed by bio-molecules.
                                                                                                    (25 marks)

3. a) Give two Major advantages of Magnetic Resonance Imaging.

(5 marks)

b) Why Magnetic Resonance Imaging primarily images the nuclear magnetic resonance signal from the Hydrogen nuclei?

(15 marks)

c) What is meant by "nuclear relaxation" and state what are the factors the Rate of relaxation depends on?

(15 marks)

d) Define the terms T_1 process and T_2 process.

(10 marks)

e) Briefly describe the components of NMR hardware system by giving a detailed diagram with the purpose of use of each in the NMR system.

(30 marks)

f) Calculate the resonance frequency of ^{1}H nuclei, if the strength of the external homogeneous magnetic field is 7.05 T. Also find from that, the energy difference between α and β spin states. The Gyro magnetic ratio for ^{1}H nuclei is 42.6 MHz T^{-1}.   (25 marks)

4. A) a) Write a brief account with the help of labeled diagram on how the X-rays are produced.   (20 marks)

b) Briefly describe the factors affecting the X-ray image quality.

(25 marks)

c) What is fluoroscopy?

(5 marks)

d) Compare Measures, Resolution, Technique, Harmful effects, Use and Number of Examinations per day of the imaging modalities Positron Emission Tomography, Magnetic Resonance Imaging and Computed Tomography.   (15 marks)

e) Calculate the potential difference across the X- ray tube if the value of the minimum wavelength of X-radiation is 0.12 nm.   (15 marks)

B) a) What is the principle of the scintillation counter used as a radiation detector in radio nuclide imaging equipment?   (10 marks)

b) Give five advantages of a solid state semiconductor over scintillation detector.

(10 marks)

5. a) What are the three principle methods used to control the radiation exposure?

(5 marks)

b) Explain how the methods mentioned in part a) are taken into consideration when assessing a radiation exposure.

(30 marks)

c) Define the quantities Equivalent dose and Effective dose.

(15 marks)

d) A worker is required to work in an area where he is subjected to different non uniform radiations, involving exposure of the whole body, the red bone marrow and the lungs. During a year the following doses are recorded

Whole body   -15 mGy from X radiation
Red bone marrow   - 50 mGy from beta radiation
Lungs   - 10 mgy form alpha radiation

Calculate the worker's effective dose and determine whether he has exceeded the permissible dose limits according to ICRP regulations.
Tissue weighting factor for both red bone marrow and lungs is 0.12

(25 marks)

e) What is meant by external and Internal Radiation hazards?

(15 marks)

f) What are the characteristics that a radioactive source which is suitable for the use in Teletherapy should have?

(10 marks)

6. A) a) What do you understand by the term cancer?

(10 marks)

b) In which ways cancer spreads in the body?

(10 marks)

c) Briefly explain the types of cancers.

(15 marks)

d) State three most common cancers found in the following groups.
          Males
          Females
          Children   (10 marks)

B) a) List the main beam performing components of a typical medical Linear Accelerator with a block diagram. (20 marks)

b) Calculate the amount of shielding thickness inters of steel needed to reduce the radiation level from a 5 Ci Co-60 source to less than 2mR h^{-1} at 1 m
    Half value layer for Co-60 for steel is   2 cm
    Tenth value layer for Co-60 for steel is   6.6 cm
    Specific gamma- ray constant of Co-60 is   1.31 R h^{-1} Ci^{-1} m^2

(15 marks)

C) a) What is the main aim of Radiation therapy?

(5 marks)

b) Briefly describe the steps to be carried out when planning for treatment in Radiotherapy? (15 marks)

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