



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED PHYSICS

MEDICAL PHYSICS 1

SPH 4160

Supplementary Examination Paper

August 2024

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Ms E MUGABE

INSTRUCTIONS

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

MARK ALLOCATION

QUESTION	MARKS
1.	40
2.	20
3.	20
4.	20
5.	20
6.	20
Maximum possible mark	100

SECTION A

1. (a) Define the following terms
 - (i) Attenuation [2]
 - (ii) Half life [2]
 - (iii) Radioactivity [2]
- (b) Describe the procedure you would follow in the event of an accident or spillage of a radiopharmaceutical. [6]
- (c) State the main beam forming components of a modern medical LINAC. [6]
- (d) What are the advantages of high dose rate brachytherapy (HDR) over low dose rate brachytherapy (LDR). [6]
- (e) On the same axis sketch the percentage depth dose curve for photons at 6MV and 15MV [8]
- (f) With the aid of a clearly labelled diagram, briefly explain the photoelectric effect. [8]

SECTION B

2. (a) Describe the role of the piezoelectric material in ultrasound transducers. [2]
 - (b) State the range of frequencies in the ultrasound region. [2]
 - (b) With the aid of a well labelled diagram, describe how an ultrasound transducer operates. [10]
 - (c) Discuss any two biological effects caused by an ultrasound beam. [6]
3. (a) What do you understand by the term radiopharmaceutical [2]
 - (b) Give any four radionuclides used in nuclear medicine. [4]
 - (b) Draw a schematic diagram of a gamma camera and briefly describe the principle of operation [10]
 - (c) If technetium radionuclide source (Tc^{99m}) was eluted from Mo^{99}/Tc^{99m} generator on Sunday at 8:30 am with activity of 565Ci. How much activity of the

source (in MBq) will be remaining on Saturday at 6:45 pm? [4]

4. (a) Identify the factors which affect X-ray production efficiency in diagnostic radiology and briefly explain how they affect it. [8]
- (b) With the aid of a well labelled diagram explain how X-rays are produced. [8]
- (c) State any two main applications of fluoroscopic imaging. [2]
- (d) Calculate the power rating of an X-ray generator that can deliver 725mA of tube current at 100kV for 0.1s exposure. [2]
5. (a) Give reasons why MR images by themselves are generally not adequate for radiotherapy treatment planning. [4]
- (b) Describe briefly image formation in Magnetic Resonance imaging (MRI). [8]
- (c) Calculate the Larmor frequency of 1H at 0.15T and 3.0T, given that the gyromagnetic ratio of hydrogen is 42.58 MHz/T. [4]
- (d) Briefly discuss the differences between T1 and T2 relaxation times. [4]
6. (a) Identify the main differences between conventional X-rays and computed tomography (CT) scans. [4]
- (b) Explain the causes of the following CT artefacts, and in each case suggest steps that can be taken to minimise them.
- (i) Beam hardening [4]
- (ii) Partial volume [3]
- (iii) Ring artifact [3]
- (c) What factors would you consider in the choice and specification of a CT unit. [6]

*******END OF EXAMINATION PAPER*******