

OLLSCOIL NA hÉIREANN
COLÁISTE NA hOLLSCOILE
GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
UNIVERSITY COLLEGE
GALWAY

WINTER EXAMINATIONS 1999

M.Sc. in Biomedical Science

CT512 Medical Imaging

Prof. J. Enderby
Prof. P.W. Walton
Dr. W. van der Putten

Time allowed : **Two** hours.

Answer **three** questions.

Q1. Answer each of the following

- (a) Describe, using a diagram, how the isotope technetium-99m (^{99m}Tc) is produced in an isotope generator.
- (b) Outline the properties that make ^{99m}Tc an almost ideal isotope for nuclear medicine imaging.
- (c) List two medical imaging studies that can be done using ^{99m}Tc labeled compounds.
- (d) Describe the operation of a gamma (Anger) camera.

Q2 Answer each of the following

- (a) Describe the production of X-rays. Give an order of magnitude estimate of the efficiency of the process with respect to the electrical power consumption of the tube.
- (b) The interaction of X-rays in a patient will produce considerable amounts of scattered radiation. What will be the effect of scatter on the final image? Give three methods which are used in radiography to minimise the effects of patient scatter.
- (c) Discuss the advantages and disadvantages of standard projection radiography compared to Computed Tomography Scanning.
- (d) Discuss the advantages and disadvantages of third generation CT scanners over fourth generation scanners.

Q3. Answer each of the following

- (a) Describe the concept of Larmor frequency and “precession” within the context of Magnetic Resonance Imaging.
- (b) Describe, with the aid of a diagram, a Spin-Echo imaging sequence.
- (c) Discuss T1 and T2 relaxation processes. Give order of magnitude values for typical T1 and T2 relaxation times encountered in clinical practice.
- (d) Magnetic Resonance Imaging does not utilise ionising radiation. Describe, however, possible safety issues related to Magnetic Resonance Imaging.

Q4. Answer each of the following.

- (a) Describe the nature of a longitudinal ultrasonic beam as used in medicine.
- (b) Outline what is meant by the characteristic impedance (ω) of a medium and give an expression for ω in terms of the density and velocity of sound in the medium.
- (c) Write down the expression for the percentage of energy reflected at an interface between media with impedances of ω_a and ω_b . Calculate the percentage of energy reflected at an air to fat interface.
- (d) Outline the principles of the sensor heads used in two, real-time, ultrasonic imaging systems.

$\rho(\text{air}) = 1.29 \text{ kgm}^{-3}$	$v(\text{air}) = 330 \text{ ms}^{-1}$
$\rho(\text{fat}) = 1000 \text{ kgm}^{-3}$	$v(\text{fat}) = 1450 \text{ ms}^{-1}$]

Q5. Answer each of the following

- (a) Define the units used in radiation safety for the measurement of activity, absorbed dose and dose equivalent. What are the dose limits for whole body exposure for radiation workers and for members of the public?
- (b) What does the ALARA concept mean.
- (c). A member of the public works in an office next door to, and at a distance of 4 metres from, a source of 10^9 Bq (27 mCi) of the radioisotope cobalt-60 (^{60}Co). If there are two tenth value layers of shielding present, calculate the dose equivalent received in a 2000 hour working year.

$$[\Gamma(^{60}\text{Co}) = 34 \times 10^{-8} \text{ Sv.m}^2/\text{MBq.hr}]$$