UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	FUNDAMENTAL OF HEALTH PHYSICS
COURSE CODE	:	DAU 24102
PROGRAMME	:	2 DAU
EXAMINATION DATE	:	JUNE 2015/ JULY 2015
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **PART A** ANSWER **TWO (2)** QUESTIONS ONLY IN **PART B**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

PART A

Q1 (a) External radiation originates in X-ray machines and other devices specifically designed to produce radiation.

(i) State the basic principles for protection against external radiation.

(03 marks)

(b) Internal radiation exposure occurs when radio nuclides from environmental contamination enter the body.

(i) Explain the process of internal radiation entry into the body.

(ii) Explain the methods to control internal radiation.

(14 marks)

(c) Criticality is a chain reaction in fissile materials (which include isotopes of thorium, uranium, and plutonium) in which the splitting, or fission, of a fissile nucleus leads to the fission of at least one more fissile nucleus.

(i) Determine criticality.

(08 marks)

Q2 (a) Geiger counter is an instrument used for measuring ionizing radiation. It detects radiation such as alpha particles, beta particles and gamma rays using the ionization.

(i) Sketch Geiger counter.

(06 marks)

(b) A scintillation counter is an instrument for detecting and measuring ionizing radiation by using the excitation effect of incident radiation on a scintillate material, and detecting the resultant light pulses.

(i) Sketch Scintillation counter.

(06 marks)

(c) Consider two radiation fields of equal energy flux. In one case, we have a 0.1MeV photon flux of 2000 photons/cm^2/s. In the second case, the photon energy is 2MeV and the flux is 100 photons/cm^2/s. The energy absorption coefficients for muscle are:

μ (energy, 0.1 MeV) = 0.0252 cm^2/g and

μ (energy, 2.0 MeV) = 0.0257 cm^2/g

(i) Calculate the dose rates for these two radiation fields.

(07 marks)

(d) A survey meter, whose time constant is 4 seconds reads 10 mR (100 μSv) per hour while measuring the radiation from a dental X-ray exposure of 0.08 second.

(i) Determine the actual exposure rate.

(ii) Calculate the dose to the dental hygienist if she had been at the point of measurement.

(06 marks)

PART B

Q3 (a) The ICRP system of radiation protection is based on three fundamental principles: justification, optimization and dose limitation.

(i) Explain these three fundamental dose limitation principles recommended by ICRP.

(09 marks)

(b) The system of dose limitation recommended by the ICRP is based on the prevention of non-stochastic effects and limitation of the probability of stochastic effects to levels deemed to be acceptable.

(i) Explain the dose limitation system based on non-stochastic effects.

(ii) Explain the dose limitation system based on stochastic effects.

(16 marks)

Q4 (a) Non-stochastic effects are characterized by a threshold dose below which they do not occur. In other words, non-stochastic effects have a clear relationship between the exposure and the effect.

(i) Determine the principle of non-stochastic effect.
(ii) State three examples of biological radiation effects due to the non-stochastic effect.
(iii) Sketch a graph dose-response due to the non-stochastic effect.
(iv) Explain the graph dose-response due to the non-stochastic effect.

(14 marks)

(b) Stochastic effects are associated with long-term, low-level (chronic) exposure to radiation. Increased levels of exposure make these health effects more likely to occur, but do not influence the type or severity of the effect.

(i) State three examples of biological radiation effects due to the stochastic effect.
(ii) Sketch a graph of dose-response due to the stochastic effect.
(iii) Explain the graph dose-response due to the stochastic effect.

(11 marks)

Q5 (a) When radiations interact with matter involve a transfer of energy from the radiation to the matter with which it interacts. The penetrating power of the several radiations depends on the type and energy of the radiation as well as on the nature of the absorbing medium.

(i) State three types of radiation.
(ii) Explain the radioactivity for these three types of radiation.
(iii) Sketch three types of radiation when it penetrates matter as shown in **Figure Q5 (a).**

(19 marks)

(b) Consider a single cell, with dimension 10μm x10μm x10μm and mass= 10^{-12} kg, in a tissue of weight 0.1g, in which a low LET particle, 1 keV/ μm , transfers 1keV to cell as it passes through the cell.

(i) Determine the radiation absorbed dose to the tissue.
(ii) Determine the radiation absorbed dose to the cell.

(06 marks)

Q6 (a) Radioactivity refers to the particles which are emitted from a nuclei as a result of nuclear instability.

(i) Define the meaning of radioactivity.

(06 marks)

(b) If 2 g of carbon from a piece of wood found in an ancient temple is analyzed and found to have an activity of 10 transformations/ minute/ gram and it half-life is 5730 years.

(i) Determine the age of the wood if the current specific activity of ^{14}C in carbon is assumed to have been constant at 15 transformations/ minute/ gram.
(ii) Calculate the specific activity of ^{14}C.

(19 marks)

- END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2014/2015
PROGRAMME : 2DAU
COURSE : FUNDAMENTAL OF HEALTH PHYSICS
COURSE CODE : DAU 24102

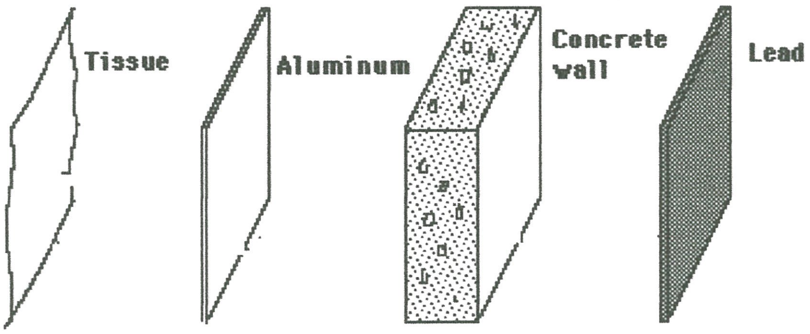

FIGURE Q5 (a)

FORMULAE

SEMESTER / SESSION : SEM II / 2014/2015
PROGRAMME : 2DAU
COURSE : FUNDAMENTAL OF HEALTH PHYSICS
COURSE CODE : DAU 24102

$$\dot{D} = \frac{\phi \dfrac{\text{photons}}{\text{cm}^2/\text{s}} \times E \dfrac{\text{MeV}}{\text{photon}} \times 1.6 \times 10^{-13} \dfrac{\text{J}}{\text{MeV}} \times \mu\,(\text{energy}) \dfrac{\text{cm}^2}{\text{g}}}{10^{-3} \dfrac{\text{J/g}}{\text{Gy}}}$$

$$\dot{D} = \frac{\phi \dfrac{\text{photons}}{\text{cm}^2 \cdot \text{s}} \times E \dfrac{\text{MeV}}{\text{photon}} \times 1.6 \times 10^{-13} \dfrac{\text{J}}{\text{MeV}} \times \mu_m \text{ cm}}{\rho_m \dfrac{\text{kg}}{\text{cm}^3} \times 1 \dfrac{\text{J/kg}}{\text{Gy}}}$$

$$\dot{D}_f = \frac{\dot{D}_t}{1 - e^{t/RC}}$$

$$SA = \lambda N = \frac{\lambda \times 6.02 \times 10^{23}}{A} \frac{\text{Bq}}{\text{g}}$$

$$\tau = \frac{T}{0.693} = 1.44T$$

$$\text{radiation absorbed dose} = \frac{\Delta E}{\Delta m}$$

$$A = A_0\, e^{-\lambda t}$$

$$\frac{A}{A_0} = \frac{1}{2} = e^{-\lambda T}$$

$$\lambda N = \frac{0.693}{T} \times \frac{6.02 \times 10^{23}}{A}$$

$$N = \frac{6.02 \times 10^{23} \text{ atoms/mol}}{A \text{ g/mol}} \times W \text{ g}$$

$$\lambda = \frac{\Delta N / N}{\Delta t}$$

Dose = Dose rate × Exposure time

$$1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$$

$$SA_i = 3.7 \times 10^{10} \times \frac{A_{Ra} \times T_{Ra}}{A_i \times T_i} \frac{\text{Bq}}{\text{g}}$$