



UNIVERSITY OF GHANA  
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**BSc. ENGINEERING**  
**SECOND SEMESTER EXAMINATIONS: 2016/2017**  
**DEPARTMENT OF BIOMEDICAL ENGINEERING**  
**BMEN 412: MEDICAL PHYSICS (2 CREDITS)**

**INSTRUCTIONS:**

ANSWER ALL QUESTIONS

**TIME ALLOWED: TWO (2) HOURS**

1. a) Differentiate between the following:
  - i. Photoelectric effect and Compton scattering (4 marks)
  - ii. Characteristic x-rays and Bremsstrahlung x-rays (4 marks)
  - iii. Pair production and Annihilation (4 marks)
- b) Explain the following:
  - i. Absorbed dose
  - ii. Dose equivalent (6 marks)
- c) Outline any three sources of environmental radiation dose and briefly discuss any two effects each on humans. (13 marks)
2. a) What is the main advantage of Scintillation counters over Geiger- Muller counters? (4 marks)
- b) Discuss how you will maximize the efficiency of a Geiger- Muller counter and a Scintillation counter. (6 marks)
- c) An industry produces alpha and beta particles as its by-products. These radioactive particles are released into the environment and contaminate the air. You are a part of a team tasked to design a single device to monitor and measure the intensities and the energies of these radioactive particles.
  - i. Produce a detailed functional diagram that describes the performance of the device. (12 marks)
  - ii. Explain in detail the strategies you have put in place in your device in (i) to entrap the particles. (8 marks)

3. a) Explain how an ultrasound pressure wave is produced. (5 marks)

b) An ultrasound pressure wave enters a boundary of two different acoustic impedances,  $Z_1$  and  $Z_2$ . Given that the acoustic impedance of the second medium is

$$Z_2 = Z_1 \left( \frac{P_i + P_r}{P_i - P_r} \right)$$

where  $P_i$  and  $P_r$  are the incident and reflected pressure waves, respectively. Show that the Reflection coefficient,  $R_p$  and Transmission coefficient,  $T_p$  are given by

$$R_p = \left( \frac{Z_2 - Z_1}{Z_1 + Z_2} \right)$$

$$T_p = \left( \frac{2Z_2}{Z_1 + Z_2} \right)$$

(12 marks)

c) Explain the physical significance of  $R_p$  and  $T_p$ . (6 marks)

4. a) What is an isotope? What is the difference between an isotope and a radioisotope?

(6 marks)

b) Explain how radioisotopes are produced and transported for nuclear medicine purposes.

(6 marks)

c) What is the difference between KV and keV in x-ray energies for diagnostic imaging and therapy?

(4 marks)