國立清華大學 102 學年度碩士班考試入學試題

系所班組別: 生醫工程與環境科學系　丙組 (醫學物理與工程組)
考試科目(代碼): 放射物理學 (2401)

1. (10%) (1) Describe the theory of braking radiation (bremsstrahlung radiation) and characteristic radiation. (2) Explain why we utilize characteristic radiation as the X-ray source in mammography.
2. (10%) (1) Explain the reason why it is difficult to stop neutrons. (2) Can we use lead to absorb neutrons? Why. (3) Describe a common way to make collimators for neutrons.
3. (10%) Describe the characteristics of the interactions of ionizing radiation with matter: (1) photoelectric effect, (2) Compton scattering, (3) pair production.
4. (10%) (1) Describe the working theory of PET (positron emission tomography). (2) Compare PET and SPECT in respects of spatial resolution, the usage of collimator, and the dosage of injected radioactivity while imaging. Explain your answer.
5. (10%) (1) Describe the working principle of a computed tomography (CT) system. (2) Define the CT number in a CT system. (3) What is the filtered back-projection (FBP) in a CT system? Describe the advantage(s) of FBP compared to back-projection scheme.
6. (10%) (1) What does "kerma" stand for? (2) Define kerma with usage of photon fluence Φ. (3) What is the difference between kerma and absorbed dose?
7. (10%) (1) Derive the quantity of half-value layer (HVL) with usage of the attenuation coefficient (μ). (2) You are assigned to build the shielding for a cobalt 60 unit which gives an exposure rate of 120 R/min at 1 meter when the source is "ON". According to the protection regulations, when the source is "OFF", the radiation level at 1 meter distance shall be less than 2 mR/h. Estimate the thickness of lead shielding required (μ of Pb: 66.0 m^{-1}).
8. (10%) (1) Plot Bragg curves for X-rays and proton beams. (2) Describe the advantage(s) of proton therapy according to the plot in (1).
9. (10%) While treating patients with malignant diseases, it is important to fractionate the radiation treatment over a period of weeks. Why?
10. (10%) (1) Assume an X-ray beam with a number of photons of N. Let photons pass through a slab of material with thickness of Δx and a number, n, of the photons will be removed from the beam. Define the linear attenuation coefficient μ with N, n, Δx. (2) Define mass attenuation coefficient, electronic attenuation coefficient, and atomic attenuation coefficient. Indicate the unit for each coefficient.