注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 109 學年度碩士班考試入學試題

系所班組別：核子工程與科學研究所

科目代碼：3202

考試科目：核工原理

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「┏由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 109 學年度碩士班考試入學試題

系所班組別：核子工程與科學研究所

考試科目（代碼）：核工原理(3202)

1. (20%, each 5%) Briefly explain the following terms:
   A. Q-value of nuclear reaction
   B. Microscopic and macroscopic cross sections
   C. Fissile and fissionable materials
   D. k_∞ and the four-factor formula

2. (20%) Nuclear reactors are powered by fuel containing fissile material (U-235 or Pu-239). A certain nuclear reactor is fueled with 1500 kg of uranium rods enriched to 20 wt% U-235. The remainder is U-238. The density of the uranium is 19.1 g/cm^3. (a) How much U-235 is in the reactor? (b) What are the atom densities of U-235 and U-238 in the rods?

3. (20%) Tsing Hua Open-pool Reactor is a reaserch reactor using TRIGA fuel at 20% enrichment with a U-235 critical mass of about 9 kg. Assume the ractor volume is 40×40×40 cm^3 and the fission cross-section in the reactor is 0.1 cm^{-1}. If the reactor has a neutron flux of approximately 10^{13} neutrons/cm^2.s, please calculate the operating power of the reactor?

4. (20%) The following table summarizes values of the buckling (B^2) and flux for critical bare reactors of various shapes. Please explain the meaning of the buckling and derive the one-group critical equation for a bare reactor as follows. L is called the diffusion length.

$$\frac{k_\infty - 1}{L^2} = B^2$$

TABLE 6.2 BUCKLINGS, B^2, AND FLUXES FOR CRITICAL BARE REACTORS (ASSUMING d IS SMALL)

Geometry	Dimensions	Buckling	Flux	A	Ω
Infinite slab	Thickness a	$\left(\frac{\pi}{a}\right)^2$	$A\cos\left(\frac{\pi x}{a}\right)$	$1.57P/aE_R\Sigma_f$	1.57
Rectangular parallelepiped	$a \times b \times c$	$\left(\frac{\pi}{a}\right)^2 + \left(\frac{\pi}{b}\right)^2 + \left(\frac{\pi}{c}\right)^2$	$A\cos\left(\frac{\pi x}{a}\right)\cos\left(\frac{\pi y}{b}\right)\cos\left(\frac{\pi z}{c}\right)$	$3.87P/VE_R\Sigma_f$	3.88
Infinite cylinder	Radius R	$\left(\frac{2.405}{R}\right)^2$	$AJ_0\left(\frac{2.405r}{R}\right)$	$0.738P/R^2E_R\Sigma_f$	2.32
Finite cylinder	Radius R				
	Height H	$\left(\frac{2.405}{R}\right)^2 + \left(\frac{\pi}{H}\right)^2$	$AJ_0\left(\frac{2.405r}{R}\right)\cos\left(\frac{\pi z}{H}\right)$	$3.63P/VE_R\Sigma_f$	3.64
Sphere	Radius R	$\left(\frac{\pi}{R}\right)^2$	$A\frac{1}{r}\sin\left(\frac{\pi r}{R}\right)$	$P/4R^2E_R\Sigma_f$	3.29

國立清華大學 109 學年度碩士班考試入學試題

系所班組別：核子工程與科學研究所

考試科目（代碼）：核工原理(3202)

5. (20%) The following figure shows the mass attenuation coefficients (μ/ρ) for a number of elements or mixtures as a function of gamma-ray energy. Please derive and exaplin why the values of μ/ρ tend to be roughly the same for all elements at energies around 1~2 MeV?