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 108 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 甲組
考試科目(代碼)：核工原理(3202)

一作答注意事項一

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。

1. (20%, each 5%) Briefly explain the following terms:
   A. Neutron diffusion and Fick's law
   B. Neutron cross sections and the mean free path
   C. Generation IV nuclear reactors
   D. Nuclear Doppler effect

The following information is taken from the technical documents of a nuclear power plant: active core height = 3.5 m, totoal fuel loading = 90000 kg; density of UO_2 = 10 g/cm^3; enrichment = 3 wt%; 150 fuel assemblies; 200 fuel pins per assembly; electrical generating capacity = 1000 MW; plant thermal efficiency = 30%.

2. (20%) Based on the above information, (a) What is the approximate thermal power output of the core? (b) What is the atom density of U-235 in the core? What is the mass of U-235 in the core?

3. (20%) Based on the above information, the core operates at full power for one year and then shuts down for refueling. During refueling, one-third of the fuel is replaced. What is the average burnup in units of megawatt days per metric ton (MWD/MTU) for the one-thid of the core initially removed?

4. (20%) Consider an infinite planar source emitting S neutrons per cm^2/sec in an infinite diffusing medium. (a) Write down the diffusion equation and the corresponding source and boundary conditions; (b) Derive an expression for the neutron flux in full space.

5. (20%) For a homogeneous mixture of U-235 and sodium in which the uranium is present in a percentage of x wt%, (a) caluclate the fuel utilization factor f and the infinite multiplication factor k_∞ as a function of x; (b) estimate the critical uranium concentration (x=?).

TABLE 6.1   NOMINAL ONE-GROUP CONSTANTS FOR A FAST REACTOR*

Element or Isotope	σ_γ	σ_f	σ_a	σ_{tr}	ν	η
Na	0.0008	0	0.0008	3.3		
Al	0.002	0	0.002	3.1		
Fe	0.006	0	0.006	2.7	—	—
^{235}U	0.25	1.4	1.65	6.8	2.6	2.2
^{238}U	0.16	0.095	0.255	6.9	2.6	0.97
^{239}P	0.26	1.85	2.11	6.8	2.98	2.61

*From *Reactor Physics Constants*, 2nd ed., Argonne National Laboratory report ANL-5800, 1963.