解釋名詞： (20%)

(a) Čeronkov radiation
(b) LET
(c) specific burnup
(d) delayed critical
(e) inhour

計算與證明題： (80%)

1. An initially pure sample of 1 Ci (curie) nuclide X_1 ($t_{1/2}$ = 13.86 days) decays into nuclide X_2 ($t_{1/2}$ = 6.93 days). Determine the time at which the activity of X_2 reaches its maximum, and also determine the value of this maximum activity in terms of Bq. (10%)

2. Show that the energy of the scattered photon (E') in the laboratory system after making Compton scattering collision with an electron is given by the form of (15%)

$$E' = \frac{E\,E_e}{E(1-\cos\theta) + E_e},$$

where E is the incident-photon energy, E_e is the electron rest-mass, and θ is the scattering angle in the laboratory system. Also show that the minimum energy of the scattered photon ($E'_{\min}$) in Compton scattering is given by

$$E'_{\min} = \frac{E\,E_e}{2E + E_e}.$$

3. Given the data as follows:

cross section (b)	$_1D^2$	$_8O^{16}$
σ_s	4.7	4.2
σ_a	0.0005	0

Given the mass density of D_2O is 1.1 g/cm^3. Avogadro's number is given by 0.602217×10^{24} #/mole and amu is equal to 1.6605×10^{-27} kg. Assume that D and O are isotropically scattered with neutrons (mass number = 1) in the CM system. The average energy loss of an isotropic scattering of an incident neutron (energy = E_0) with a single nucleus (mass number = A) is given by

$$\overline{\Delta E} = \tfrac{1}{2}(1-\alpha)\,E_0,$$

where α denotes the collision parameter. The corresponding average lethargy gain is given by

$$\xi = 1 + \frac{\alpha}{1-\alpha}\ln\alpha.$$

(a) Determine the moderation power of D_2O. (10%)
(b) Determine the average number of elastic scattering collisions that the 2 MeV neutron is needed to be made with D_2O, before it reaches 0.0253 eV. (10%)

4. An infinite bare slab of moderator of thickness $2a$ containing uniformly distributed sources emitting S_0 neutrons/cm^3-sec. Calculate the number of neutrons per cm^2-sec absorbed within the slab. (15%)

5. Consider a spherical, multiplying reactor core is immersed in an infinite, non-multiplying reflector. Derive the critical radius of the spherical reactor core which satisfies the transcendental equation of the form as follows: (20%)

$$BR\cot BR - 1 = -\frac{D_r}{D_c}\left(\frac{R}{L_r} + 1\right),$$

where the subscripts c and r denote reactor core and reflector, respectively.
Notice that ∇^2 for the spherical coordinate (if angular independence) is given by

$$\nabla^2 = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) = \frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r}.$$