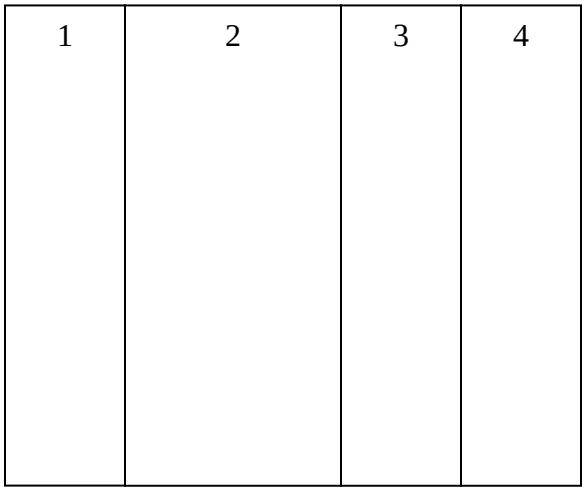
22.106 Neutron Interactions and Applications
Problem Set 3

Due SES #12

Question 1

Shielding: Monte Carlo simulation



Problem Description

Slab 1: Source
- Source of Cf-252 producing neutrons of 10^8 neutrons per second uniformly distributed in the slab.
- Assume that all neutrons are produced at 1 MeV
- Width of 1 cm

Slab 2: Moderator
- Material is borated concrete
- Width of 5 cm

Slab 3: Gamma shield
- Material is lead
- Width of 2 cm

Slab 4: Person
- Width of 3 cm

Density of lead 11 g/cc
Density of concrete 2.5 g/cc
Density of the californium 15g/cc

Total cross section of lead: 4.39 b
Absorption cross section of lead: 0.0033 b
(n,2n) cross section of lead: 0.09 b
Assume lead is a pure component of Pb-208.

Total cross section of borated concrete: 3.50 b
Absorption cross section of borated concrete (if E > 0.1 MeV): 0.01 b
Absorption cross section of borated concrete (if E < 0.1 MeV): 1.5 b
Assume that the molecular mass of concrete is 60 g/mol and is made of a single component.

Total cross section of Californium-252: 0.1 b
Absorption cross section of Californium-252: 0.001 b

Total macroscopic cross section of person: 1 cm^{-1}
Absorption cross section of person: 0.2 cm^{-1}

The system is surrounded by a vacuum. Assume that the remainder of all total cross sections is elastic scattering and that all scattering is isotropic in the lab system.

Questions

1) Using Analog Monte Carlo, compute the flux and absorption rate in the person (slab 4) and include the uncertainties.
2) Compare the figure of merit if you were to use:
    - Implicit Capture
    - Source Biasing
    - Implicit Capture and Source Biasing

Question 2

Explain in your own words the basic idea of variance reduction and discuss its importance in Monte Carlo simulations.

Question 3

Describe how the lack of information of potential V is circumvented in the R-matrix derivation.

Question 4

Explain in your own words the roles of experimental data and theoretical modeling in evaluating nuclear cross sections. Why do we need to evaluate data?

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