

1. (10%)

(a) All nuclei scatter neutrons, what distinguishes an elastic scatter and an inelastic scatter? (4%)

(b) Calculate the microscopic one-group thermal absorption cross-section of ^{135}Xe at

100°C using the following data :

$$\text{non-1/v factor } g_a (100^\circ\text{C}) = 1.21,$$

$$\sigma_a (20^\circ\text{C}) = 2.65 \times 10^6 \text{ barn.} \quad (6\%)$$

2. (12%)

Draw a block diagram showing the major steps of a U/Pu fuel cycle. Label clearly what material is transferred between steps.

3. (12%)

It is proposed to produce 25kg of 90 w/o for a nuclear weapon by enriching 20 w/o fuel from a research reactor.

(a) How much fresh reactor fuel would be required?

(b) Compute the total SWU required, assume the tails enrichment is 0.2 w/o.

$$\text{Data : } V(0.2) = 0.832, \quad V(0.9) = 1.758, \quad V(0.002) = 6.188$$

4. (20%)

- (a) An isotropic point source emitting S neutrons per second is placed in an infinite medium. Show that the flux distribution is given by $\Phi(r) = \frac{Se^{-r/L}}{4\pi Dr}$
- (b) An infinite moderator contains uniformly distributed isotropic sources emitting s neutrons/cm³ - sec.

Determine the steady-state flux and current at any point in the medium.

5. (20%)

A spherical reactor core (radius R) is surrounded by reflector (thickness T).

- (a) Use one-group theory, write down the reactor equation in the core and the diffusion equation in the reflector. (6%)

- (b) What are the boundary conditions that must be satisfied by Φ_c and Φ_r . (6%)

- (c) Derive the critical condition for this reflected spherical reactor. (8%)

6. (10%)

In the laboratory system, when a neutron is scattered from hydrogen at rest, what is the angle between the scattered neutron and the recoiling proton? (Assume that the mass of neutron is the same as the mass of proton.)

7. (16%)

Explain the following terms :

- (a) specific burnup
- (b) Fick's diffusion law
- (c) Nuclear Doppler Effect
- (d) Oklo phenomenon