Neutronics:

1. Question 1
    a. Write the 2 group diffusion equation, put it in operator form and solve for k
    b. Find the resonance escape probability
    c. Find the thermal nonleakage factor
    d. If your known burnup rate is 3.0 pcm per day, what is the core lifetime?
    e. With a known volumetric expansion of $2 \times 10^{-4}/^{0}C$, find the reactivity feedback for Delta T = 100 C.
2. Estimate the critical fuel mass given a table of number of assemblies and source multiplication.
3. Derive the neutron source distribution and the wall flux in a spherical magnetically confined fusion reactor. (some parameters were given to calculate wall flux)
4. Given that the reactivity in a system is given by $\rho = \rho_o + \gamma q(t)$
    a. Write the appropriate point kinetics equations
    b. Find the second order differential equation for $\frac{\partial q(t)}{\partial t}$
    c. Solve for ρ_o
    d. Solve for $q(t)$

Materials:

1. Given an alpha of known energy
    a. Calculate the max energy transferred to carbon and tungsten
    b. Calculate the average number of displacements created by each
    c. Calculate the ratio $\frac{T_{\max} carbon}{T_{\max} Tungsten}$
2. Given a known thermal neutron flux in a reactor (10^{22} n/cm^2-s)
    a. Calculate the rate of (n,γ) reactions in iron given capture cross section.
    b. If the gamma released is 10 MeV calculate the energy of the recoil iron ion.
    c. Calculate dpa/sec from iron recoils
    d. For a 0.5 MeV neutron flux of (10^{22} n/cm^2-s), given elastic scatter cross section calculate dpa/sec from neutron scattering.
3. Sputtering
    a. Relationship of yield at t=0 and t= ∞
    b. Given $\frac{N_A{}^S(\infty)}{N_B{}^S(\infty)}$ find $\frac{N_B{}^b}{N_A{}^b + N_B{}^b}$
    c. Calculate $\frac{Y_A(\infty)}{Y_B(\infty)}$
4. DBTT
    a. Define DBTT
    b. How do you measure DBTT
    c. Radiation effect on DBTT and why it is important
    d. How do you counteract embrittlement
5. Swelling and Creep
    a. Name several differences between swelling and creep.
    b. What is the temperature effect on swelling and creep?
    c. Why are swelling and creep a concern?

Thermal Hydraulics

1. Heat transfer
    a. Write the general heat transfer equation
    b. Calculate the temperature profile in a fuel plate. (include fuel, cladding, and coolant)
    c. Draw the temperature profile in a fuel pin
2. In a BWR
    a. Give the 1D temperature profile in the reactor
    b. Write the 1D energy equation
    c. Calculate the power once T=Tsat (onset of nucleate boiling)
    d. Calculate the actual power profile once stable boiling is achieved.
    e. What is the location of onset of nucleate boiling?
    f. Explain subcooled boiling phenomenon and conditions under which it can occur.
3. Control volume analysis
    a. Write the mass momentum and energy equations in control volume format
    b. Write the momentum and energy equations in control volume format during a LOCA.
    c. Write the ECCS criteria such that the ECCS mass flow rate is greater than the leak.
4. Dimensionless Parameters
    a. List 5 dimensionless parameters, their definition, and their significance
    b. What dimensionless parameters must be equivalent for two systems to have momentum equivalence?
    c. What dimensionless parameters must be equivalent for two systems to have energy equivalence?
    d. What dimensionless parameters relate to the friction factor and how?