SH2600 Oral Exam Questions

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2022

Set A

1. What is the Q-value of the nuclear reaction? What is the mass defect of a nucleus? What is the binding energy of a nucleus? How does the stability of a nucleus relate to the binding energy? Can kinetic energy be released/consumed in a nuclear reaction? Can that be determined from the binding energy of reacting nuclei?
2. What is the neutron flux ϕ? What is the difference between neutron flux, neutron beam intensity and neutron current? What is the one-group neutron flux? What is thermal flux? What is 2200 meters-per-second flux? What is the physical meaning of volume-and-energy-integrated neutron flux?
3. What is the cause of the presence of the so-called resonances in the energy dependence of some cross-sections? How can we compute one-group cross sections? How can we compute thermal cross sections at a specific temperature?
4. What is the critical energy of fission? What condition nuclei of a certain nuclide must fulfill to be called "fissile"? What materials are called fertile? Give examples. Define the conversion (breeding) ratio. What reactors are called breeder reactors?
5. What are the prompt and delayed neutrons? What is the "precursor"? What do β and β_i represent (when talking about delayed neutrons)? What is the effective delayed-neutron fraction, β_{eff}? How does β_{eff} differ from β? What is the average kinetic energy of the prompt and delayed neutrons coming from thermal fission of ^{235}U?
6. What is the physical meaning of the multiplication factor k? Describe the fission chain reaction in a critical reactor in terms of the prompt chain length and the decay time of precursors.

Set B

1. What is the typical structural arrangement of nuclear fuel? What are the major characteristics of PWRs and BWRs? What are the major advantages/disadvantages of GCR and LMFBRs?
2. What are the simplifications made in the diffusion approximation? Why are boundary conditions needed for the diffusion equation? Formulate some boundary conditions. What are the basic ideas of Fick's law? Express Fick's law for the neutron flux mathematically for 1-D and 3-D problems.
3. In very general terms describe the relationship between the diffusion equation and the criticality equation. Does the criticality equation always have a solution? What is the solution of the criticality equation in a homogeneous finite cylindrical reactor?
4. Describe the physical meaning of factors in the six-factor formula. Is the value of k_∞ larger in heterogeneous or homogeneous reactors?
5. Why neutrons must get moderated in thermal reactors and not in fast reactors? Describe the material options for coolant/moderator/fuel in thermal and fast reactors. Give example of fast reactors.
6. What factor decides the power of a critical reactor (without an external source of neutrons)? What happens to reactivity and power of a critical reactor when the reactor gets suddenly coupled to an external source of neutrons?

Set C

1. In general terms, explain the fuel temperature (prompt or Doppler) feedback.
2. In general terms, explain the moderator temperature (delayed) feedback. Explain the term "under/over-moderated system".
3. How is xenon formed in thermal reactors and why do we care? Will xenon concentration increase or decrease after reactor shutdown, and why? Explain the xenon oscillations in thermal power reactors.
4. What do we mean by the frequency response of a reactor? What reactor characteristics are the reactor frequency response? Can we measure or compute the frequency response?
5. What do we generally mean when we say a reactor is stable? Explain what is the reactor transfer function. How do the poles of the transfer function relate to reactor stability and why? Does the reactor transfer function (and reactor stability) depend on the system power?
6. Describe and explain Welton's criterion for reactor stability.