

Jadavpur University
B.Power Engg. 4th Year 2nd Semester Examination 2018
Nuclear Power Generation

Time: 3hrs

Full Marks:100

Answer any Five

1. Define neutron flux and derive its unit.
Derive the relationship between neutron flux and a nuclear reactor's power density.
Define microscopic and macroscopic cross sections of neutron interactions and state their units.
Define mean free path of a neutron and write the expression for the same. 5+5+5+5
2. Calculate from first principles the thermal energy available from 1 kg of Natural Uranium which contains 0.7% of Uranium 235. Hence calculate the mass of Fuel required for a 220MWe Nuclear Reactor operating at roughly 30% efficiency.
Define Burn up. If the Burn up for the reactor in question is restricted to 20000 MWd/T what is the reactor's re-fuelling period? 4+6+4+6
3. Calculate from first principles the Energy of a Thermal Neutron.
Enumerate the different terms in the 4 factor formula for neutron multiplication factor and state how these depend on reactor power.
From first principles derive an expression for energy loss of a neutron colliding with a moderating atom of mass A. 6+4+10
4. Define the terms Moderating Ratio and Slowing Down Power for a Nuclear Reactor.
Calculate the number of collisions required to thermalize a neutron at 1MeV Energy using Heavy Water moderator with $\xi = 0.509$
Explain how the moderator reactivity defect changes from an under-moderated to an over-moderated reactor. 4+6+10
5. Define reactivity and state its units.
Starting from point kinetic equations derive expressions for prompt jump factor and stable reactor period
Hence deduce what happens if the fraction of delayed neutron precursors β becomes 0. 4+10+6
6. Write the reaction for Xe production in a nuclear reactor. With suitable assumptions express the dynamics of Xenon production and decay after the reactor is shutdown from a steady-state power.
Now, assuming that the reactor is operating at a steady power P explain how the Xe flux changes with time if the power is increased in a step.
What is Xe oscillation? 2+8+6+4
7. With a direct schematic represent a Direct Cycle BWR
What are the problems associated with a Direct Cycle BWR?
How is a BWR controlled?
What is the typical enrichment used in a BWR? What is fuel-grading? 4+6+6+3+3
8. With a neat schematic explain the Turbine Following Reactor mode of operation of PWR?
What are the advantages of a CANDU reactor over a PWR?
Enumerate the different control and shutdown mechanisms in a CANDU PHWR 10+4+6