List of Concepts (Nuclear Engineering Fundamentals and Reactor Physics)

Topics taken from NUCL 300, 310, 510 (501)

- Neutron transport and diffusion equations
- Slowing down theory and flux separation of space and energy
- Neutron spectrum in different types of reactors
- Two-group diffusion equation and its application
- Resonance absorption and escape probability
- Effect of temperature on resonances (Doppler effects and MTC)
- Reactivity balances for design and operation
- Physics of delayed neutrons and its importance in reactor control
- Point kinetics equations and approximate solution methods
- Reactivity feedbacks and transient behaviors
- Fuel depletion and nuclide transmutation
- Xenon oscillation
- In-core fuel management
- Fuel cycle analysis
List of Concepts (Fluids, Heat Transfer, and Reactor Safety)

Topics taken from NUCL350, 351, 355, 402, 551

1. Introduction to Nuclear Thermal-hydraulics Systems
2. General Balance Equation
4. Non-dimensional Analysis and Scaling Parameters
5. Heat Conduction in Solid
6. Viscous Stress and Laminar & Turbulent Flow Velocity Profile
7. Transient Diffusion Problem for Momentum and Energy and Penetration Depth Concept
8. Turbulent Flow Formulation and Reynolds Stress
9. Viscous and Turbulent Stress Distribution in Pipe Flow
10. Prandtl Mixing Length Model and Universal Velocity Profile for Turbulent Flow
11. Prandtl Number Effect on Temperature Profile in Turbulent Flow
12. One Dimensional Formulation and Closure Relations
13. Forced ConvectionTransient Flow Analysis using Integral Momentum Equation
14. Natural Circulation Flow Analysis using Integral Momentum Equation
15. Control Volume Analysis for Nuclear Reactor System and Application to Various Accident Analyses
16. Two-phase Flow Regimes and Boiling Flow Regimes in Terms of Heat Transfer
17. Local Instant Formulation of Two-phase Flow Based on Single-Phase Flow Formulation and Jump Conditions
18. Basic Concept and Parameters in Two-phase Flow such as Void Fraction, Flow/Static/Equilibrium Quality
19. Derivation of Two-phase Flow Equations Based on Averaging
20. Closure Relations and Correlations for Two-phase Flow
21. Two-phase flow instabilities (density wave, excursive) in reactor systems inclusive of reactivity feedback
22. Boiling heat transfer (pool, forced convective, and post-dryout) concepts including related CCFL, and CHF/DNB and PDO phenomena.
23. Sub-channel analysis including mixing and void-drift effects basic concepts
24. Two-fluid modeling basic concepts
25. Containment phenomena such as steam condensation and NCG effects, and engineered safety systems thermal-hydraulics
26. Off-site radionuclide plume transport and safety assessments including building wake effects and radiological dose evaluation.
List of Concepts (Nuclear Materials)

Topics taken from NUCL320, 420, 501, 520
1. Thermal Properties of Solids
2. Microscopic and Macroscopic Diffusion
3. Basic Radiation-Matter Interactions
4. Binary Elastic Collisions Theory
5. Inter-atomic Potentials and Cohesive Energy
6. Cross Sections
7. Particle Energy Loss
8. Electronic Stopping Power
9. Ion Range
10. Displacement Cascade
11. Channeling & Focusing
12. Ion and Neutron Damage
13. Sputtering & Blistering
14. Point Defects Clustering, Diffusion, and Kinetics
15. Swelling
16. Creep
17. Radiation Hardening
18. Embrittlement

Note that the review part of NUCL420 will be topics from NUCL520.
List of Concepts (Nuclear Radiation Detection and Protection)

Topics taken from NUCL200, 300 (205, 305, 504, 501)

1. Atomic structure, Bohr's atomic model
2. Nuclear structure and estimate of nuclear radii
3. Binding energy for atoms and nuclei, mass defect
4. Uncertainty and exclusion principles
5. Radioactive decay, decay rate, activity - concepts and calculations
6. Energies of emitted radiation during decay
7. Neutron interaction with matter
8. Charged particle interaction with matter
9. Photon interaction with matter
10. Biological effects of radiation
11. Shielding, build-up factor
12. Radiation detection principles and technology
13. Counting statistics and error propagation
14. Radiation protection