

Syllabus

ENU6052 – Particle Transport Methods and Applications

Description

The course discusses neutral particle interactions and related cross sections, Linear Boltzmann equation in “forward” and “adjoint” forms and their applications, perturbation and variational techniques for particle transport problems, different numerical methods for solving the linear Boltzmann equation in serial and parallel environments, and limitations of these methods for solving real-life problems.

Outline

- Chapter 1 - Cross Sections
- Chapter 2 - The Linear Boltzmann Equation (LBE) and its application for neutral particle (i.e., neutron & gamma) transport
- Chapter 3 - The adjoint LBE, "importance" function and its applications
- Chapter 4 - Introduction to linear perturbation theory and variational methods for particle transport
- Chapter 5 - Integral form of the Boltzmann equation and its use for solving special problems
- Chapter 6 - Numerical methods and their associated issues for solving the integro-differential form of the Boltzmann equation
 - P_n & Simplified P_n (SP_n)
 - Double P_n (DP_n)
 - Discrete ordinates (S_n)
 - Even-Parity S_n
- Chapter 7 - Acceleration methods for the S_n methods
- Chapter 8 - Techniques for generation of quadrature sets for the S_n methods
- Chapter 9 - Issues related to convergence, stability, and accuracy of the S_n methods
- Chapter 10 - Parallel computing algorithms for S_n methods
- Chapter 11 - General discussions on current research

Text Books

1. Lecture notes & handouts
2. “Computational Methods of Neutron Transport,” by E. E. Lewis and W.F. Miller, 1984, American Nuclear Society (optional)
3. “Nuclear Reactor Theory,” by G.I. Bell and S. Glasstone, 1970, Van Nostrand Reinhold Company (optional)
4. “Methods for Steady-State Reactor Physics in Nuclear Design by R.J.J. Stammler and M.J. Abatte, 1983, Academic Press (optional)

References

- “Nuclear Reactor Analysis” by J.J. Duderstadt and L.J. Hamilton, 1976, Wiley & Sons.
- “Transport Theory” by J.J. Duderstadt and W. R. Martin, 1979, Wiley & Sons.
- “Computational Methods in Reactor Physics” by H. Greenspan, C.N. Kelber, and D. Okrent, 1968, Gordon and Breach Science Publishers.
- “Numerical Methods of Reactor Analysis” by Clark and Hansen, 1964, Academic Press.
- “Transport Calculations for Nuclear Analyses: Theory and Guidelines for Effective Use of Transport Codes” by R.D. O’Dell and R.E. Alcouffe, 1987, LA-10983-MS.
- “PENTRAN –Parallel Environment Neutral-particle TRANsport Users Guide” by G.E. Sjoden and A. Haghightat, 1996, University of Florida Transport Theory Group (UFTTG).

Grading

One mid-term exam and one final exam (70%)
Homework & Computer assignment (30%)
Project (10% Bonus)