Book Review

Nuclear Reactor Theory and Design. By Roger A. Rydin. University Publications, Blacksburg, Virginia (1977). 385 pp. $32.50.

Nuclear Reactor Theory and Design by Roger A. Rydin is written in an informal and easy-to-read style. It can be used as a textbook for a senior or first-year graduate course in a nuclear engineering program. These students should be required to solve many of the excellent problems at the end of the chapters. The book could also be used by other technical students who are interested in understanding the primary aspects of core reactor physics. The neutron and nuclear physics needed to understand the reactor theory is included so that the student does not have to refer to many other books. The problem sets make the book uniquely suited for teaching reactor design. Some problems familiarize the student with digital computer codes that may be used by designers of large pressurized or boiling water reactors. Examples of digital computer codes considered are as follows: EXTERMINATOR, WIGLE, RAUMZEIT, TWIGLE, STINT, and GAMTEC.

The reactor design project problem set is perhaps the most useful one. The design project includes solving depletion, power distribution, power normalization, and xenon and samarium poison problems. The problems have been carefully selected and should provide valuable training and experience for the student reader.

Each chapter begins with an introductory paragraph that helps the reader place the material in the chapter in its proper perspective. The introductory paragraph also briefly describes the contents of the chapter.

To provide some specific information about the book, parts of the book are now briefly discussed. The diffusion equation basis is reviewed in Chap. 4. In Chapter 5, the one-speed neutron transport and diffusion equations are solved. Infinite media point, line, and plane source solutions are explicitly presented. A one-group model for the critical slab reactor is considered together with the higher λ modes. A good set of procedures for solving the multiregion equations is provided.

In Chap. 6, few-group equations and solutions are developed. Matrix methods for obtaining the energy and space dependence are presented. A two-group, reflected slab core solution is obtained.

"Perturbation Theory and Reactor Kinetics," Chap. 7, is one of the better chapters. Using both flux and adjoint flux solutions for an unperturbed problem, a perturbation expression for the change in reactivity is found. In the space-time kinetics area, the time-dependent flux of a slab reactor is considered when a control rod is inserted in one side of the reactor. The point kinetics equations are also solved for one group of delayed neutrons for several model reactor operating conditions. The use of the computer code EXTERMINATOR is the suggested method for an (r,z) model control rod study of a water reflected reactor. This study is a problem defined at the end of Chap. 7. Either the RAUMZEIT or WIGLE code may be used to solve a six delayed neutron group one-dimensional spatial transient problem.

Reactor poisoning, depletion, and temperature effects are considered in Chap. 8. The discussion of spatial xenon oscillations is especially well done. Curves are presented of the time dependence of the axial oscillations of a large power reactor. Both stable and unstable oscillations are included in the discussion. Fuel, moderator, piping, and steam generator temperature effects are also discussed. In a short depletion section, the burnup of ^{235}U and the buildup of ^{239}Pu are modeled. The problems at the end of Chap. 8 include a reactor core design project. Groups of students are expected to solve the assigned design problems.

In Chap. 9, neutron slowing down is considered. Energy loss in neutron-nucleus elastic scattering is developed. The neutron flux and slowing down density for several hypothetical model problems are derived. Among these, the energy dependence of the flux is found when the capture is a slowly varying function of energy. The temperature dependence of neutron moderation in materials with resonances is included in narrow resonance (NR and NRIA) approximation models in Chap. 10. The GAM computer code multigroup slowing down equations are also discussed.

The hydrogen gas and bound hydrogen moderator models are used for scattering of neutrons in the thermal energy group. The thermal-neutron space energy problem treatment used in the THERMOS code is also briefly discussed. Here, integral transport theory is employed to describe the spatial distribution.

Although the designer of thermal reactors will benefit most from this introductory textbook, the material is often sufficiently general to also benefit the designer of fast reactors. In fact, one of the problems discussed in the book is slowing down of neutrons in iron and sodium. The book is also recommended for students interested in reactor theory. It should help the student prepare for more advanced courses in reactor physics.

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