BOOK REVIEW

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Fundamentals of Nuclear Reactor Physics

Author E. E. Lewis

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Reviewer Larry R. Foulke

Professor Lewis has done an admirable job of providing new insights and fresh looks at reactor physics as he has taught the subject matter for a remarkable career as an educator and textbook writer. I have all of his textbooks and I refer to them often.

I will refer to this textbook often as well because I like his treatments of many practical subjects for practicing engineers. At last we get a text that casts the transient thermal behavior of reactors into a mental model using time constants, the parameters that characterize the speed with which things change in a reactor. Discussion of reactor dynamics in terms of time constants is very useful in understanding the wide range of time-dependent phenomena in a reactor. Even though my teaching is based on a similar time constant delivery, I found new insights from the text. It proves that no matter how competent you feel you may be in a subject area, you can always learn something from others.

The chapter introductions provide succinct overviews of what chapters are all about and what is important. For example, the introductory paragraph of Chapter 8, "Energy Transport," is a good example of the author's setting the stage with a high-level description of the limitations and restraints faced in the design of nuclear reactors, and the Pressurized Water Reactor Example of Chapter 8 is a good illustration of a high-level, first iteration for a reactor design.

Lewis has always had great conversational style in his texts, which are easy to read. This book is characterized by conventional material clearly written. There are good illustrations of cross-section behavior (the Yang material), consistently presented and easy to read. Another strength of the text is the frequent referral to typical reactor types to illustrate how and why reactor compositions and lattices vary.

All this praise aside, I think Lewis has missed a good opportunity to move away from extensive treatments of the four-factor formula. The days of the practical usefulness of the four-factor formula are long past. Our understanding of the physics of neutron transport and the quality of the cross-section data have improved to the point that the practicing reactor engineer no longer needs to measure or calculate the historical four factors (η, ε, p, and f) when designing a nuclear reactor. Most practicing reactor physicists now find that neutron balance provides a much better framework for understanding neutron behavior.

The design world today uses multigroup diffusion theory methods, nodal methods, and Monte Carlo methods to calculate and design reactors. While the historical parameters may present a nice picture of the neutron energy cycle, it is disappointing that a new text on the fundamentals of nuclear reactor physics does not leave the student with a better sense of modern methods.

Lewis's treatment of energy-averaged cross sections in Chapter 3, "Neutron Distributions in Energy," leads to some useful pedagogy in the table of average microscopic cross sections for fast, intermediate, and thermal energy regimes. While the cross sections are not portrayed as being sufficiently accurate for design work, they are portrayed as being useful for back-of-the-envelope calculations. These averaged cross sections are then used to make approximate calculations of k-infinity from simple equations that depend upon enrichment, volumes of materials, and number densities. The results from these simple equations give reasonable estimates of reactor parameters. So, if one is going to use the factors in the four-factor formula, Lewis provides some fresh looks at the calculation of these parameters.

Professor Lewis provides many nice kinetics approximations that lead to understanding of reactor behavior in different time regimes. But, for today's computer-literate students, it would be beneficial to incorporate high-level programming languages such as MATLAB into coursework to solve and illustrate the time behavior of reactors under different conditions.

While the text is clear and readable—as are all texts by Dr. Lewis—I found that the chapters on energy transport, reactivity feedback, and long-term core behavior were worth the price of the text in terms of new insights and illustrations.

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