Book Reviews

Nuclear Reactor Analysis. By James J. Duderstadt and Louis J. Hamilton. John Wiley and Sons, Inc., New York (1976). 650 pp. $23.95.

The teaching of reactor physics or reactor analysis is not particularly easy. Some decades ago, when we had One Textbook and no Professors, we had no problems. My experience was typical. I was hired, not knowing buckling from inhour. I found my office, sharpened a pencil, and began to gaze dreamily into the middle distance when Jack Chernick appeared. He handed me a book. "Read it," he said. Two weeks later, I handed it back. "I've read it." "OK," he said, "now you are a nuclear engineer." The book was Glasstone and Edlund's, and that was training in the 1950's.

Nowadays matters are more complex. We have PSARs, intervenors, the OPEC, and battalions of young engineers who should be taught something about nuclear energy. But, how much, and how? In particular, how should reactor physics be taught? There are several possibilities. I have tried the traditional "physical" approach, beginning with the physics of fission, the notion of a chain reaction. Then, on to the diffusion of neutrons, in space and energy . . . . I have tried the formal approach, beginning with the Liouville equation and the heavy apparatus of statistical mechanics. And, recently, I essayed the relevant approach, cajoling a colleague to begin the course with fiery lectures on "Energy Needs," "Project Independence," and "The Twenty-First Century, Where Will We Be?" No matter, the result is always the same. Midway through the course, usually when we are slogging through two-group, two-region criticality, eyelids begin to droop and breathing becomes slow and easy. Let us face it, ladies and gentlemen, reactor physics is not an exciting subject. We need all the help we can get. (The advanced course is no better. One student of mine opted for flight duty in Vietnam rather than endure a set of lectures on Wiener-Hopf decomposition and the Milne Problem. He survived combat, and his wise choice has, I hope, been rewarded by high position in the military-industrial complex.)

Duderstadt and Hamilton's *Nuclear Reactor Analysis* does help. It is a big, beautiful book, handsomely produced, a veritable coffee-table volume, $10\frac{1}{4} \times 7\frac{1}{4} \times 1\frac{1}{2}$ in. It has 15 chapters and contains 650 pages, countless handsome tables and figures, and 352 exercises for the student. It is written in a lucid, relaxed, almost chatty style. There is an occasional lapse ("Hence a capability is required. . . .") that may be laid to the problem of joint authorship. The book has been written, the authors say, for the "modern nuclear engineering student." Thus, there is considerable emphasis on numerical methods and on the non-nuclear aspects of core design. One finds the traditional material augmented by sections on thermal-hydraulic analysis and fuel management. (The modern nuclear engineer can identify "yellow-cake" and the Dittus-Boelter correlation, as well as "half-range completeness.") One unfortunate archaism that plagues us still is reference to company reports (GEAP-4598, WAPD-TM-22) for important work. One would hope that valuable material, a dozen years old, would be established in the open literature by now.

The conventional material is treated in the traditional, "physical," manner, the transport equation being introduced first and diffusion theory deduced from it. Diffusion theory for monoenergetic neutrons and the equations of point kinetics are used to develop an understanding of how reactors work. In a later section, the multigroup diffusion theory is developed, and slowing down theory and thermalization appear, subsumed under "Fast (Thermal) Spectrum Calculations and Fast (Thermal) Group Constants," perhaps as they should be in modern reactor analysis! A chapter on cell calculations in lattices—with a good section on escape probabilities—completes the discussion of neutron physics. The last section of the book is devoted to the non-neutronic topics I alluded to earlier. While there is not much that one can do about the choice of topics in such a text, the balance of numerical and analytical techniques in the presentation gives this book its distinction. I found this feature to be most attractive.

No book attempting to cover so wide a field is free of error or superficiality. I wish there were a fuller discussion of decay heat. The famous $t^{-1.2}$ formula does not appear. I wish the discussion of collision kinetics was more up-to-date. There is no reason to omit nuclear inelastic scattering, especially as the day of the fast breeder approaches. Furthermore, the authors strongly suggest that anisotropic CM scattering is of little importance in light nuclei (but see BNL-400). But these trifles should not obscure the main point that this is an attractive, rich, wide-ranging text that is a pleasure to read. It is, by the way, the second, not the first edition. The first, which will surely be a collector's item, was illustrated by drawings based on the movie "Fritz the Cat." These, alas, are absent from the volume sent me by John Wiley and Sons. Imagine! An X-rated text on reactor analysis (What hidden meanings now for buckling, inhour, and . . . extrapolation length!). Teacher need never ask for help again.

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About the Reviewer: Noel Corngold, professor of applied physics at the California Institute of Technology, returns to these columns with this refreshing review of a new text. Dr. Corngold completed his graduate studies at Harvard University and was at the Brookhaven National Laboratory for many years. His recent research interests have been in reactor physics, particularly in the theory of neutron scattering and transport.