Part II. Engineering Applications

Sec. I. The Use of SEA in Preliminary Design

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Sec. III. Example of Response Estimation

15. Vibration of a Reentry Vehicle

This book will be appreciated by anyone involved in vibro-acoustical analysis of systems. There is little doubt that SEA, itself, will see more applications in the future.

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About the Reviewer: Raymond Brach has been a member of the faculty of the Aerospace and Mechanical Engineering Department of Notre Dame University since 1965, with special interests in dynamics, vibrations, acoustics, engineering design, and the application of statistics. Professor Brach's academic training began at the Illinois Institute of Technology and was completed at the University of Wisconsin in 1965.

Elements of Nuclear Reactor Design. By Joel Weisman, Ed. American Elsevier Publishing Co., Inc., New York (1977). 466 pp. $50.75.

This unique volume with contributions by nine authors ambitiously attempts to cover the major engineering sciences that form the basis for the analysis of a nuclear power reactor. The title may be somewhat misleading, since the emphasis throughout the 14 chapters is on the "elements" rather than on "design." Furthermore, only the nuclear core and the immediate vessel are discussed, and little mention is made of design and analysis for the balance of a power plant. Such a limitation on the scope of material is, of course, necessary to keep the book to a manageable size; however, the material covered still presents the authors with a formidable challenge. The sciences of materials, thermodynamics, reactor physics, shielding, heat generation and transfer, fluid flow, stress analysis, radioactivity, and reactor kinetics are all covered. The treatment of these subjects is explicitly oriented toward reactors, and is, for the most part, developed from first principles, presupposing little prior familiarity with the subjects on the part of the reader.

The book is divided into five major sections. The first section, "The Nuclear Reactor System," contains three chapters that review current power reactor concepts, reactor materials, and the thermodynamics of power cycles. None of these chapters requires any specialized engineering background to be understood, and all are well written and easily read.

However, the second section, "Nuclear Design," presumes that the reader has a familiarity with the diffusion equation and elementary reactor theory. In a chapter on reactor physics computations, the multigroup diffusion equation, its numerical solution, and the generation of group constants are well covered. Briefer sections on burnup calculations, reactivity control, and fast reactors complete this overview of core physics. The second chapter in this section presents neutron and gamma-ray shielding techniques, ranging from simple exponential attenuation to computer techniques. Unfortunately, the attempt to present so much material in one chapter has forced the description of some methods or concepts to become abbreviated and occasionally even vague.

In the third section, "Thermal and Fluid System Design," the three chapters on heat generation and transport, fluid flow, and heat transfer are oriented specifically to reactor core analysis. Taken as a whole, these chapters form an excellent condensation of the basics involved in thermal hydraulic analyses. The first chapter on heat generation and transport is well developed analytically, although the somewhat obsolete hot-channel factor concept is used extensively. The remaining two chapters on fluid flow and convective and boiling heat transfer make extensive use of empirical correlations and analytical results, often without mention of the restrictions on the results and, in the case of the analytical equations, without a hint of the derivation. While space limitations promote this philosophy of presentation and while some teachers believe the "plug and chug" approach to be the way to present the complex field of fluid flow and heat transfer, this approach is at odds with the developmental approach adopted in most of the other chapters.

The fourth major section of this volume deals with the mechanical and material aspects of reactor systems. A short introductory chapter presents an excellent summary of stress-strain relations and structural properties of materials starting from an elementary level. The next chapter then applies these concepts to vessel and pipe stress analyses. Since many nuclear engineering curricula do not traditionally include this topic, these two chapters offer a very useful distillation of elementary stress analysis as applied to nuclear systems. This section concludes with a very complete chapter on the material considerations of fuel element design.

The final section entitled "Safety Analysis" presents an introduction to three important areas of reactor design. The first chapter reviews the sources and type of radioactivity generated in a power reactor and discusses the release mechanisms of this radioactivity and their consequences. The second chapter in this section gives a very complete overview of the many thermal hydraulic problems encountered in the analysis of a loss-of-coolant accident. This chapter is very readable and has brought together for the first time much of the basic material used to treat this important problem. Finally, there is a chapter on reactivity insertion accidents in which reactivity feedback mechanisms, basic neutron kinetic models, and descriptions of various reactivity accidents are presented. This chapter, while not presenting the more advanced kinetic analysis techniques, serves as a good introduction to the topic.

Overall, the book is an interesting collection of special topics, each of which stands alone and can be read and used without reference to the rest of the book. Each chapter

contains a problem set, and many chapters have solutions to illustrative problems. Often, with multiple-authored books, subject overlap, changes in style and nomenclature, and varying levels of presentations make the transition from one topic to another quite difficult. Such faults are not evident in *Elements of Nuclear Reactor Design*, helped to a large extent by the almost total independence of each chapter topic from the others. For an expensive book, it is surprising more effort was not made in the composition and choice of illustrations. The rigid left justification of all equations and figures is often unattractive. Furthermore, the figures differ in style not only from chapter to chapter but even within a chapter—perhaps evidence of a "cut and paste" approach to assembling figures. More important, several figures contribute little to the concept being discussed, while in other sections, proper illustrations would have greatly helped communicate ideas or information.

After perusing this volume for several months, I have been left wondering what is the place for this book, which has much excellent material nicely summarized. The authors' stated purpose is for the book to "serve both as a reference and as a text for courses in reactor engineering and reactor design." This is an ambitious goal but one this reviewer feels has not been totally achieved. There is very little design *per se* contained in the book, and there is too little material on any one topic to serve as the sole text for a semester course on that topic. Furthermore, in the attempt to cover such a breadth of material, rigor and clarity have occasionally been sacrificed for brevity. I suspect that a student who did not previously have a background in the subjects discussed in several chapters would not gain a very clear understanding or be able to solve very many problems after reading those chapters. As a reference, this book will serve as an excellent introduction to many topics, but for an advanced graduate student or practicing engineer, it may be only marginally useful, since the material in many (although not all) chapters does not describe the currently used analysis and design techniques but rather tends to emphasize the basics. This book will probably find its niche as a review reference for graduate students who have previously been exposed to much of the subject matter or as a secondary text for many courses in nuclear engineering.

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