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Book Reviews

Digital Computers and Nuclear Reactor Calculations. By WARD C. SANGREN. Wiley, New York, 1960. 208 pp., $8.50.

High-speed digital computers have been extensively used for the past decade in reactor design and application. Thus a book addressed to the reactor uses of computers would appear to be a logical and useful work. However, the field covers a broad range of technologies, starting with the physics and engineering representations of reactor phenomena and their representation by mathematical equations, the reduction of these equations to forms which can be solved on a digital computer, the development of techniques for achieving such solutions economically, and finally, the process of preparing a program which will enable a given digital computer to perform the required calculations. It is a difficult task to cover adequately this broad range of topics in a short book.

Dr. Sangren's book generally takes an intermediate approach which would not satisfy or be particularly useful to people with experience in the field, but which is probably, at least in parts, too difficult for casual observers or people working in the more elementary parts of the problem. This difficulty for the inexperienced may also arise from the occurrence of technical terms with special meaning which are not always defined in the text.

I suspect the major use of this book will be to provide a quick background for a beginning nuclear engineer or scientist to orient him to the uses of the digital computer in his proposed field, and to guide him to areas which he might wish to pursue more thoroughly by reference to the current technical literature or other text books.

The first half of the book deals with an introduction to reactor problems, the fundamental characteristics of digital computers themselves, programming, and numerical analysis. The second half of the book deals with actual examples of reactor calculations, covering such topics as fission product poisoning, diffusion and age-diffusion calculations, transport equation and Monte Carlo calculations, kinetics, depletion, shielding, and engineering calculations. The pace of the book is somewhat uneven in its demands on the reader's knowledge, passing from simple explanations of readily understandable matters, to rather complicated equations and derivations within the same section.

A further source of annoyance to the inexperienced reader is the rather general evidence of poor proof reading in the book. There are numerous obvious mistakes in the equations and inconsistencies in the notations. If the reader is aware of this, the book has the virtue of pulling together in a few pages a description of the significant techniques and problems involved in the use of digital computers for reactor design and analysis.

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[*Editor's Note: Mr. Parker has been associated with the nation's atomic energy program since 1942 when he joined the staff of the Chicago Metallurgical Laboratories, part of the war-time Manhattan Project. He has directed Radiological Sciences activities at the Hanford Atomic Products Operation since 1944. Currently, as Manager of General Electric's Hanford Laboratories, he is responsible for the conduct of the extensive nuclear research and development program of the Hanford plant.*]

Nuclear Radiation Engineering, An Introduction. By F. W. HUTCHINSON.

This book does not define the field of nuclear radiation engineering. Apparently the intended topic is the application of radiation sources, particularly artificial radioisotopes to the various industrial processes. Curiously enough the text indicates the actual engineering areas involved in nuclear reactor engineering. Nuclear radiation engineering, it states, involves a knowledge of atomic and nuclear causes of radioactivity, the kinds of radioactivity, the energy release associated with disintegration, and the effects of radiation. Why these are not equally significant in nuclear reactor engineering is not made clear.

The book addresses itself to an audience of administrators and engineers "at the rim of the atomic circle." It also aims at lowering the industrial language barrier between the executive and the atomic scientists which "causes concern on the part of the executive when he is required to make a decision based on advice or evidence which he does not fully understand. . . ."! The result is a peculiar mixture of background data intended to be palatable to an engineering-oriented audience.

It is divided into four parts. Part I is an introduction to atomic and nuclear structure. Some of this is done with great success as in the account of the identification of cathode rays as electrons. Other portions are less successful, as when equations incompatible with the elementary nature of the text are introduced. Acceptability of the format is nullified by the request to accept as axiomatic Einstein's equation for the energy equivalence of mass. If the nuclear radiation engineer needs scientific background in his field, this equation, the very core of it, must surely be explained and not made an axiom.

Part II is concerned with atomic and nuclear energy and for the most part satisfactorily condenses a great deal of science and technology into four short chapters. There are some serious blemishes. As an example, the account of the origin of x-rays is limited to the mechanistic picture of electron jumps within an atom (cluttered by a complicated formula for wavelength, useless to this audience). The text describes only characteristic x-radiation (because that is easy to explain?) and omits *bremsstrahlung*. From the engineer's point of view the preponderance of x-ray energy comes from this continuous spectrum whose origin is not disclosed at all.

The brief excursion into nuclear reactor principles is also oversimplified perhaps to the point of confusing the thoughtful reader.

Part III is entitled, "Radiation Absorption and Measurement." That part of it which deals with the subject seems to be very well done and appropriate to the intended level. It includes, however, a six page chapter on health physics which is deplorable.

Part IV is a dictionary of atomic and nuclear terms and phrases. The inaccuracies made necessary in part by overcondensation in this section may be acceptable for the intended readers, although this reviewer does not support that approach to teaching. Presumably a serious student at any part of the rim of the atomic circle would equip himself with one of the recognized glossaries.

In summary, the book is an unbalanced pot-pourri of information for the engineer. Its influence on the executive could actually increase the "annoyance, irritation, and resentment" of his specialists. Sooner or later, an educator will attempt the task of teaching executives to leave technical decisions to the technically informed.

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Reactor Code Abstracts*

Abstract No. 7

1. Code designation: FIRN (T-LC-9); "A Two-Dimensional S-4 Transport Code in R-Z Geometry."
2. Computer for which designed; programming system: IBM-709, Fortran.
3. FIRN is a two-dimensional S-4 transport code in R-Z geometry. It is, actually, an adaptation of the Los Alamos TDC code, an S-4 code written by Bengt Carlson and Clarence Lee. Three separate compilations of FIRN exist at present, namely, one-group, four-group, and six-group versions.
4. Restrictions on complexity of problem: Mesh structure must contain fewer than 60(z) × 40(r) mesh intervals in one- or four-group problems, or under 55 × 40 in six groups.
5. Running time: About 1 hr for a one-group, 2000 zone problem.
6. In use—available upon request.
7. *Reference:* Bengt Carlson, Numerical solution of transient and steady-state neutron transport problems. LA-2260 (May, 1959).

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Abstract No. 8

1. Code designation: SWAKRAUM—"A Program for Computing the Spatially Dependent Thermal Spectrum"
2. SWAKRAUM, a FORTRAN-SAP program for the IBM 704 (32K Memory) is now available for distribution. This program computes the spatially dependent thermal spectrum in one-dimensional slab-lattices, using the P_1, P_3, or double P_1 approximation. The method of solution is based on a two- or four-mode representation of the energy dependence of the thermal group. Thus it is assumed that the flux spectrum everywhere in the lattice can be well represented by a linear combination of two or four characteristic spectra. The resulting set of two or four coupled differential equations are solved simultaneously by a noniterative procedure.

   Special features of the program include:
   (*a*) Blackness routine permitting the use of blackness theory in P_1 calculations.
   (*b*) Printout of spectrum averaged materials constants and activations for any arbitrary detector.
   (*c*) Use of any arbitrary slowing-down kernel with a diagonal P_1 component. The P_2 and P_3 components are assumed to be zero.

   A maximum of 18 regions and 251 mesh points can be treated while the energy spectrum can be calculated at up to 37 energies. Running times can be computed from the following approximate formula:

$$\begin{aligned}\text{Time (sec)} = 30 &+ 33 \text{ (number of spectra)}\\ &+ 8 \text{ (number of materials)}\\ &+ 1.7 \text{ (number of mesh points)}\end{aligned}$$

   Thus most problems take from 4 to 8 min, and it is this speed which represents the main improvement over similar programs.

   An ALTAC version of SWAKRAUM for the Philco 2000 is now in preparation.
3. *Reference:* G. P. Calame and F. D. Federighi, A variational procedure for obtaining spatially dependent thermal spectra. KAPL-M-GPC-2 (December, 1959).

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* Operated for the U. S. Atomic Energy Commission by the General Electric Company.