BOOK REVIEWS

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.

Nuclear Reactor Kinetics and Control

Author	J. Lewins
Publisher	Pergamon Press, Inc., New York (1978)
Pages	264
Price	$15.00 paperback; $30.00 hardback
Reviewer	Clarence E. Lee

Nuclear Reactor Kinetics and Control is partitioned into nine chapters covering an introductory review, neutron and precursor equations, elementary solutions of the kinetics equations at low power, linear reactor process dynamics with feedback, power reactor control systems, fluctuations and reactor noise, safety and reliability, nonlinear systems, and analog computing.

The introduction briefly reviews the Laplace and Fourier transforms, transfer functions for feedback and control, linear stability using Routh's criteria, Nyquist and Bode methods for stability and transient response, root locus, stability margins, and the fundamentals of probability theory. Positive and negative feedback conventions are clearly delineated. The author's commentary for the prerequisites in the introduction is realistic relative to student survivability, at least in undergraduate courses in differential calculus, automatic control, reactor physics, and heat transfer. Implicitly contained therein is complex algebra, a practical introduction to Laplace transform, and probably basic computer skills. Depending on the student's preparation and background, this chapter might be the most useful yet difficult to understand in the entire book. The style and content are excellent, concise, and clear, but considerable supplementary work may be necessary if excellence in an area is lacking. Such preparatory efforts are certainly worthwhile since then the rest of the text is quite straightforward. The problems at the end of each of the chapters are used to complement and extend the topics covered in the text.

The lumped model neutron and precursor equations are addressed in Chap. 2 beginning with a review of the physical constants, absolute and relative yields, fractional yields and time constants, energy spectra, and spread in neutron yields. Effective weighted kinetics coefficients are examined from the standpoint of linear, flux, and adjoint weighting. Adjoint weighting is used to relate reactivity to the critical eigenvalue lambda. Reactivity perturbation, reproduction time, lifetime, and effective precursor fractions are examined for multigroup diffusion problems.

Chapter 3 returns to a discussion of the fundamental concepts of the kinetics equations at low power. Then, development of exact solutions of the kinetics equations is addressed for several situations when the reactivity can be treated as a specific function of time. Source variations are treated by Laplace transform and a short study of the inhour equation properties is made. A step change in reactivity is also treated. Several approximate methods are reviewed including the one-precursor group, constant precursor, prompt jump approximation, and step reactivity change in the one-precursor group problem.

The process dynamics of the reactor with simple forms for the associated plant and control effects is treated in Chap. 4 using the frequency approach and linearized systems. The neutronics transfer function and its approximations are treated. Boiling water reactor void effects and reactor thermal transients including internal feedback transfer functions are discussed and analyzed. Two temperature (fuel and moderator) feedback systems are analyzed for static and dynamic stability. Lumped boiler transfer functions including throttle variations are considered. The xenon transfer function (neglecting direct yield) is derived from the linearized xenon-iodine equations, and a simplified neutronics-temperature model is developed and used to determine the required temperature feedback to suppress gross xenon instabilities. Xenon spatial oscillations and modal fluctuation analysis are discussed. Reactor control elements, methods, and typical describing functions are outlined.

The overall operating control systems for commercial reactors are discussed qualitatively in Chap. 5. Load demand and general control considerations are reviewed including control action, pressure or temperature load variations, load coupling and following, and system stability. Sample control calculations are reported. Light water reactors, including both boiling water reactors and pressurized water reactors, are surveyed. A foldout of the Kraftwerke Union Biblis 1000-MW(electric) plant control system is supplied. Heavy water reactors discussed include the steam generating and Canadian CANDU with direct digital control. Gas-cooled reactors, including the MAGNOX, advanced gas-cooled reactors, and high temperature gas reactors, are also considered. Finally, sodium-cooled fast reactor prototypes are surveyed.

The lumped constant property reactor stochastic model is developed in Chap. 6 to represent departures from the mean behavior. This is followed by a discussion of autocorrelation and cross-correlation functions and their Fourier transforms. Power spectral densities, the Rossi-alpha, and Feynmann-alpha experimental situations are examined and interpreted.

Chapter 7 deals with the safety and reliability of the reactor control system. Safety guidelines and philosophy are discussed. Logical and safety circuits are examined for monitoring parameters and event and fault trees. System reliability and the survival functions for different failure rate models are derived.

Nonlinear systems are studied in Chap. 8 using state space and its equations in the time domain. The Nordheim-Fuchs and the constant heat removal models are used to illustrate autonomous two-state systems. After a review of possible nonlinear trajectories, the Liapunov V function is introduced, discussed, and applied to the prompt jump model. Pontryagin's control theory is outlined. Reactor startup and xenon shutdown are addressed as optimal reactor control problems.

Analog computing is described in Chap. 9. Sample programs are given for a variety of examples, including low power kinetics, xenon shutdown, isotopic buildup of the transuranic elements, and nonlinear kinetics for the trajectories around an equilibrium point with Newton's law of cooling (illustrated on the cover). If the requisite electrical equipment is unavailable, but, instead, access to a digital computer is possible, the problems discussed here can still be addressed as they are interesting from the nuclear engineering standpoint.

With respect to typesetting errors, the failure rate is roughly a Gaussian centered about Chap. 3 with 85% of the total occurrences (about 25) in the first four chapters. The necessary corrections are reasonably clear if the reader has been following the development.

There are approximately 25 tables and 132 figures in the main text, with more included with the problems. The 123 problems are of high quality, pertinent, and a valuable supplement to the text. Numerous term project ideas are included. The 131 references give the reader quite adequate additional direction for consultation. There are never less than 7 problems in any chapter, and usually a dozen or more are available.

Overall, the text is excellent, quite readable, and has a lively style. It represents a significant contribution to the literature. This reviewer enjoyed using it in a graduate nuclear control systems course. It is recommended to the general American Nuclear Society membership as timely and important reading for an overall understanding of kinetics and control.

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Simulation of Energy Systems
(Part 1 and Part 2)

Editor	Kenneth E. F. Watt
Publisher	Society for Computer Simulation, P.O. Box 2228, La Jolla, California (1980)
Pages	Part 1, 100; Part 2, 220
Price	$20.00 per book; $35.00 per set
Reviewer	Archie A. Harms

These two slim volumes of about 100 pages each represent Vol. 8 in the Simulation Councils Proceedings Series. The 20 papers contained herein, however, do not represent the proceedings of a conference but seem to be specifically prepared for Simulation Councils, Inc. The subjects covered are generally diverse but all touch upon some aspect of energy and power flow. Most papers have several authors who are associated with various industrial and academic institutions and generally represent the engineering sciences.

The word "system" in the title and in the papers is to be broadly interpreted. In some papers, system may be a compact energy conversion device such as a pump or a compressor while in others it may be the steam supply network of a nuclear reactor or a gas-water reservoir complex. Some of the papers deal with central problems of electrical utilities: unit expansion, optimal scheduling, and modeling of domestic power consumption patterns. Other papers discuss solar heating of buildings, queuing theory application to underground mining, the modeling of Saudi Arabia's water and power demand, and the exotic topic of the characterization of "boom-to-bust" towns.

The mathematical and conceptual level of these papers could best be described as fitting into the framework of operations research. Differential and/or integral equations describing continuity and balance relations together with empirical or semi-empirical algebraic relations are formulated and the system solved by computer to obtain time trajectories of various dependent parameters. Techniques such as linear and dynamic programming, optimization, and finite differences are the standard tools. Some papers, however, focus primarily on the descriptive aspects of their theme while others seem to assume even little in the area of computer programming and flow charting. These contrast with two papers on the theory and application of bond graphs.

The books are hardbound, the type is reproduced from typewriter-prepared manuscripts, and the figures are clear and consistent. Like the journal that carries this review, each paper has a biographical sketch and photograph(s) of the author(s).

In addition to the value of these volumes as an informative compendium on simulation of energy systems, they also seem to possess considerable merit as a listing of "what seems to work" at a practical level. As in other related areas of mathematical modeling, these papers provide a good