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Book Reviews

System Analysis of Nuclear Reactor Dynamics. By Lynn E. Weaver. Rowman and Littlefield, Inc., New York (1963). 285 pages. $6.95 hard cover; $4.95 soft cover (ANS members 15% discount).

This book is one in a series of concise authoritative treatises on important subjects in fields of nuclear science and engineering representing the joint efforts of the ANS and the Division of Technical Information of the USAEC. As the author states, "The purpose of this work is to present the various concepts in linear system analysis and their use in analyzing the stability and dynamic behavior of fundamental reactor systems."

Chapter 1 deals with complex plane transformation. Included in 16 pages are the definitions and properties of linear differential equations, introduction and application of Laplace transforms, poles, zeros and residues. System transfer function, superposition integral frequence response, and the Fourier transform are handled in a concentrated form which is a useful review for the reader who has already mastered this field.

Chapter 2 develops the application of the transfer function described in Chapter 1 in relating the response of a device to an input stimulus. To do this the author first presents the basic properties of simple electrical and mechanical networks. The methods of analysis are developed along classical lines such as the writing of differential equations applying loop and nodal analysis and Kirchhoff's laws in the case of electrical networks. Once the basic principles of the networks are established, the concept of the system transfer function is applied, giving examples of electrical and mechanical (including rotational) systems.

To a person familiar with electric and mechanical components and at home with concepts of torque, friction, voltage, current and so forth, this chapter is sufficient in providing a fundamental tool in the analysis of nuclear reactor systems. It is, however, too lean for those readers not well grounded in electricity or mechanics.

Chapter 3 deals with the fundamental relationship describing the dynamics of a nuclear reactor without and with delayed neutrons. This chapter, which combined with Chapter 5 is the heart of the book, continues with reactor startup, reactor transfer function, reactivity and period relationship, reactor transfer function for parametric excitation during transient, transfer function of circulating fuel reactors, effect of reflector upon reactor kinetics and reflector-perturbed reactor transfer function. It is an extremely condensed treatise of reactor dynamics with a number of tables and graphs.

Chapter 4 describes the various methods used for determining the stability, frequency response and time response of control systems. A later chapter deals with the related topic of synthesis of control systems, but mainly from the standpoint of error compensation and not from the standpoint of overall design strategy, which has rightly been considered as outside the scope of the book.

Chapter 5 introduces nuclear system analysis by discussing various linear reactor models with internal feedback, using methods presented in the previous chapter. This chapter, which is the most extensive chapter in the book, starts with analysis of the zero-power reactor with reflector and, after discussing nuclear temperature and density coefficients, continues with the linearized kinetic equation with temperature feedback. This is followed by discussion of step changes and reactor stability. There is a discussion of a homogeneous water boiler and a heterogeneous boiling-water reactor followed by handling of fission-product poisoning and its effects on stability. The determination of the reactor transfer function from frequency and transient response is followed by discussion of reactor control by control rods. The chapter ends with a discussion of stability analysis using the describing function with the frequency response methods. Due to the compactness of the treatise, the reader must be thoroughly acquainted with the subject to take full benefit of this chapter.

Chapter 6 describes the use of analog computers in nuclear reactor simulation. A surprising amount of material has been concentrated into 25 pages; computing circuits for summation, integration, multiplication, division, function generation, etc., preparation of block diagrams and scaling of problems to obtain accuracy within the response limitations of the computing hardware.

The basic techniques are then illustrated with examples, including simultaneous differential equations (kinetic equations), Xenon buildup and radioactive decay. For those who have access to an analog computer an extensive list of computer diagrams for transfer-function simulation are included in the appendix.

Chapter 7 deals with system design. As a control system must correctly respond to both command inputs and to system disturbance the designer must insert compensation networks into the design. This chapter attempts to give the reader a feeling for the problem the designer has in compensating his system so that it will meet the response specifications. First, various specifications are defined, classifying them into time domain and frequency domain. Then, error constants are discussed as a tool in the relating of frequency and transient response. With this background the remainder of the chapter presents, with examples, the two basic techniques for compensation of control systems: series compensation and minor-loop compensation. Finally a time-domain synthesis technique which lends itself to machine calculation is presented. The chapter is well organized and does what it attempts,—i.e., it gives the reader an appreciation of the designer's problem of system compensation.

Chapter 8 relates the previous chapters to the statistical control theory. Starting with definition of mathematical tools, gaussian distribution, correlating functions and special density, it gives the input-output relation for correlation functions and spectral densities, and an application of random-noise theory to measurement of system characteristics. The same chapter goes through elementary calculus of variations, formulation of the mean square error for linear systems, and free-configuration minimization of the mean square error. Finally there is a discussion about minimization of the effect of reactor noise.

Although this book is published as a monograph it covers a number of different fields of engineering discipline and it can be called a condensed handbook rather than a monograph. The author was very successful in condensing a tremendous volume of material in a relatively small book of 285 pages. He left out only one aspect: warning the reader in the preface that in all chapters some previous background in the related subject is assumed. The only disadvantage of his treatment is to force the user to look up a number of references in fields which are out of his own specialty and could not be thoroughly explained in such condensed form. The book is a very valuable help for the nuclear engineer and the low price puts it within his reach.

The industry desperately needs these types of condensed handbooks with an extensive list of references.

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About the Reviewer: George G. Biro is on the staff of Gibbs & Hill, Inc., consulting engineers and constructors, New York City. He is the author of Modern Methods in Stress Analysis of Continuous Structures *(1949) and at present is in charge of shielding on nuclear power plants. He obtained an MS in Civil Engineering in Brunn, Czechoslovakia, and an MS in Nuclear Engineering at Columbia University. He is a member of ANS, APS, and ASCE.*

The Technology of the Treatment of Uranium Concentrates. By N. P. Galkin, A. A. Maiorov and U. D. Veryatin. The McMillan Co., New York, (1963). $7.50. 204 pages.

This monograph, translated from the Russian, gives an account of the chemistry and technology of uranium extraction from the ore-concentration stage to metal production. In addition to several chapters devoted to uranium refining, a portion of the book is devoted to the production of the intermediate compounds (uranium oxides and uranium tetrafluoride) from which the metal is produced.

In a treatise of this kind one might expect to find major emphasis on Russian work in this field. Such is not the case for this book. The reader will find no references to Russian technology and only a few references to Russian chemical literature. For the most part, the book is a review of the published literature of the U. S., Canada, and Europe. The first chapter traces the history of the development of the uranium industry, but only for the Western countries. Estimated uranium production figures are given for the 'capitalist' countries, but none are given for the communist countries.

Despite the title, the book emphasizes strongly the chemistry, rather than the technology, of uranium separation and conversion into intermediate compounds,—in fact, the book is notably weak in technology. The principal value of the monograph lies in its excellent account of the large variety of chemical methods for separating uranium from impurities with which it is associated in nature. A large number of flowsheets for