some very interesting results on reliability problems in regard to spinning reserve and units-commitment. The chapter is concluded by a study on reliability by allowing partially off (derated) capacities for generating units.

Chapter 8, "Direct Current System Reliability Evaluation," examines the modeling of the reliability for ac–dc and dc–ac converters and their inclusion in a dc transmission system. Equivalent models are presented for a bridge with spare components and for multiple bridges. When these equivalents are used in the dc transmission the reliability of the overall system is estimated by use of total and conditional probabilities.

In the preface the author mentions that the book is written for "average engineering graduates with little background in probability." Consequently, it is understandable that the book lacks the rigor in the exposition and emphasis on the particular underlying hypotheses associated with the model. For example, on page 62 one should read; as $n \to \infty$, $Q^n \to 0$, $I - Q^n \to I$; therefore, $I + Q + Q^2 + \cdots + Q^{n-1} \to [I - Q]^{-1}$ rather than equality signs for the two last arrows. Another example on page 69 concerns the use of Markov chain concepts to compute mean time to failure (MTTF) in a Markov process without mentioning that $\Delta t + 0(\Delta t)$ should appear in the denominator of the second member of the expression for N. Furthermore, since every step in the Markov chain lasts Δt, the MTTF is the sum of terms from N multiplied by Δt. As $\Delta t \to 0$, $\Delta t/(\Delta t + 0(\Delta t)) \to 1$: justifying the passage from the Markov chain to a Markov process.

A minor comment may be mentioned in regard to the notations. It seems surprising to see the right-hand side of an equation as a row vector and the left-hand side as a column vector. In Chapter 6 definitions for P_c, R_{L1}, R_{L2}, Q_{L1}, Q_{L2} are given on page 208. However, they conflict with $P_c(1,2)$, $P_c(1 \text{ or } 2)$, and $P_c(0)$ of Table 6.3 (page 215). Possibly $R_L{}^2$, $2R_LQ_L$, $Q_L{}^2$ would have been more appropriate.

In some specific paragraphs some additional aspect could have been used to clarify the conditions of the applicability of the method. The formula for the cumulative frequencies f_n' on page 133 is true only in very specific cases; for example, it happens to be true for the model of statistically independent generating units and the Markovian load model of Chapter 3. However, a correcting term f_c should be included in general [6]. The reliability indices computed on the basis of mean values do not require a modeling by a Markov process [7]. In Chapter 4, the reader may find it annoying that the spinning reserve is defined in the last part instead of in the beginning of the chapter.

In conclusion the author seems to have reached his goal, i.e., to present a book which is useful for practicing engineers interested in reliability studies. However, a prospective reader should realize that the underlying hypotheses and limitations of the methods may not be stated very rigorously. Consequently, he should be careful before attempting to draw general conclusions. The book may also be helpful in a junior–senior level course as a guide to a survey of technical papers over the last decade on the reliability of power systems.

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The Origins of Feedback Control—O. Mayr (Cambridge, Mass.: M.I.T. Press, 1971, 151pp.)

This is a compact analytical study of the development of automatic control up to about 1800 written by a man fully qualified both as engineer and historian. It originally appeared in German in 1969, and it is now translated into English by the author, who is able to express himself well in mathematics and systems theory, as well as in German and English.

Dr. Mayr begins with a careful explanation of the meaning of automatic control, using as an example Watt's famous centrifugal governor of 1788, the introduction of which is often said, erroneously, to be the beginning of feedback control. He then takes up cases of automatic control found in the historical literature, beginning with the water clock of Ktesibios of the third century B.C. He examines each in the light of modern systems theory in order to determine what type of control is entailed. Each important case is presented verbally, graphically, and mathematically. The block diagrams that Mayr uses to clarify the functions of components and the flows of information and energy through the systems are most illuminating. They reveal a surprising variety of patterns of control systems that should be interesting and perhaps useful to engineers.

To the historian the most interesting phenomenon is the revival of automatic control in the eighteenth century. Watt's governor and the float regulation of the water closet are familiar examples, but many other ways of controlling pressure, temperature, velocity, and water level appeared in the same period. Mayr cannot fully explain this renaissance, but he makes interesting suggestions. He also points out gaps and unanswered questions in the evolutionary story (268 notes of a historical nature entail many interesting aspects!). He finds that the chief types of control were developed independently, with no cross links in experience and no awareness of common principles. He also finds no trace of a *general* theory of control before the work of Maxwell in 1868.

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Power System Operation—R. H. Miller (New York: McGraw-Hill, 1970, 179 pp.)

This little book consists of 11 chapters which cover the first 135 pages of the book, four appendices, and an index. It was written for power system dispatchers for the purpose of acquainting them with the broader aspects of the power system. The book can, likewise, serve as a text in an undergraduate course on "power system operations," and a leading power school is already using it for that purpose.

The book has been prepared on an elementary level with almost all uses of mathematics avoided. Appendices covering trigonometry and phasors are included with those individuals in mind who were not previously exposed to that material. Exercises are included at the end of each chapter, with answers provided in the back of the book.

Chapter 1 is entitled "Basic Principles;" here the author defines resistance, inductance, capacitance, reactance, impedance, and real and reactive power. "Transfer of Energy in Power Systems" is the subject of Chapter 2. The division of load between generators is described as well as their parallel operation. The emphasis of Chapter 2 is on the physical paralleling of units and systems, with very brief mention of stability. Chapter 3 is entitled, "Var Flows." Losses due to vars, var compensation, and various var sources are briefly described in Chapter 3. Economic Operation of Power Systems is covered in Chapter 4. Input/output and incremental heat rate characteristics of thermal units are described as well as the equal incremented loading criterion. Nuclear and hydro generation are just briefly mentioned. Losses and their consideration by means of penalty factors are also briefly mentioned.

Economic interchange is well covered, but system security, a most important subject area today, is only mentioned in the chapter summary. Power system control is covered in Chapter 5. Frequency control, flat frequency, flat tie line, and the common tie line with frequency bias are well described.

Measurements of energy, energy accounting and inadvertent energy are described in Chapter 6. Telemetering methods, both analog and dispatch are covered in Chapter 7. System reliability factors are most lucidly covered in Chapter 8. Various factors that effect the reliability of a system are discussed such as spinning reserve, automatic load shedding, opening tie lines, restarting generation equipment, interconnections, etc. The basic principles of power system protection, better known as protective relaying, is covered well in Chapter 9. Basic relaying principles and the uses of a variety of relays such as inverse time relays, directional relays, power relays, and distance relays are described.

Power system stability is briefly reviewed in Chapter 10. Three modes of stability, steady state, transient, and dynamic, are briefly defined. EHV, both ac and dc, is the subject of the last chapter. A variety of subjects are covered here such as bundled conductors, line reactance compensation with series and shunt reactors, rectification and inversion, the advantages and disadvantages of dc transmission, and parallel operation of ac and dc.

Four appendices appear at the end of the book. The first appendix contains an introduction to trigonometry, and the second appendix describes the use of vectors in electric power engineering. The third appendix describes the revolving field, and the fourth, the control of power flow with phase shifting transformers. It would probably have been more appropriate if the material contained in the last two appendices could have been worked into the text material.

Suggestions for further study given by the author appear at the end of the book. They are insufficient, poorly chosen, and consist of eight sources, some of which are difficult to obtain. The classical texts have not been included.

In summary the book serves its stated purpose well and can also serve as text material in an introductory undergraduate course in power system operations.

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Stability Theory of Dynamical Systems—J. L. Willems (New York: Wiley; London: Nelson, 1970, 201 pp.)

The stability problem of dynamical systems is a field of intensive research in which new results are continually obtained, especially by mathematicians. At the same time the subject is of great interest to engineers and there is a constant need for books written for them containing an up-to-date exposition of the subject. The book on stability theory by Willems fulfills this need in a commendable way. In the course of seven chapters it gives a survey of methods of stability analysis of linear and nonlinear differential and difference equations.

The concepts of various forms of stability (viz. Lyapunov stability, Lagrange stability, input–output stability, etc.) and their mathematical significance in connection with the analysis of linear, nonlinear, time-invariant, and time-varying systems are discussed at the outset. This is followed by a chapter on Lyapunov's direct method in which stability and instability theorems for autonomous and nonautonomous systems are derived. A brief description of the principles underlying the methods of constructing Lyapunov functions is also given.

The well-known methods of stability analysis of linear systems possessing rational transfer functions using phase-plane techniques and the methods of Hurwitz, Routh, and Nyquist are described. Results concerning the applicability of the Nyquist criterion for systems possessing nonrational transfer functions are mentioned. The design of feedback systems with a prescribed degree of stability using Bode and root locus plots is discussed. The chapter on linear nonstationary systems reveals the difficulties involved in dealing with such systems. As the author points out, the formally straightforward methods known hereto are of limited value in practice.

The chapter on methods of dealing with nonlinear systems using Lyapunov theory and phase-plane techniques, as well as the more recently developed frequency domain methods due to Popov, Sandberg, etc., form an important part of the book. The final chapter gives methods of stability analysis for discrete systems.

In general, the topics dealt with have been selected with care. However, no mention is made of the method of describing functions widely used in the stability analysis of nonlinear control systems. The text is presented in a fluent style, and in spite of its mathematical rigor, rendered transparent by avoiding unnecessary sophistication. The prerequisites are kept to a minimum. The value of the book is greatly enhanced by copious references and problems at the end of each chapter. The book should be useful for students and practising engineers.

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Stability Theory—H. Leipholz (New York: Academic Press, 1970, 277 pp.) (A translation of the first German edition, Stuttgart: B. G. Teubner, 1968.)

Most of the theory that is presented deals with perturbations of the initial conditions or the parameters of ordinary differential equations. Classical developments of Hurwitz, Routh, Lyapunov, Poincare, Bendixson, and others in this field are carefully systematized and are rigorously set forth. The first part of the book, which develops the theory of stability of linear and nonlinear differential equations in an abstract form, closes with a section on mathematical methods of approximation with particular emphasis on the perturbation procedure, the method of Galerkin, and the method of harmonic balance developed by Krylov and Bogoljubov.

The second part of the book, which constitutes more than half of the volume, treats a number of special examples of stability theory in mechanics. The illustrative examples on stability of motion include a particle in a central force field, the three-body problem, nonlinear vibrations of single-degree-of-freedom systems, the gyroscope, rockets, satellites, wing flutter, and control systems. Finally, there is a long section on elastic stability that emphasizes recent results for ideal systems with conservative and nonconservative external forces. The kinetic stability criterion advanced by Ziegler receives particular attention in this treatment.

The work calls attention to ambiguity in the meaning of stability that has occasionally caused fruitless arguments. The standard of rigor in the book is high, and the explanations are clear. Although the discussion is related to classical dynamical systems, the general theory is applicable to questions of stability of various physical systems, and conceivably to mathematical models outside of the physical sciences. Anyone who wishes to gain an insight into stability theory will find the work highly profitable, provided that he has a suitable background in the theory of ordinary differential equations.

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