Preface

When the writing of basic text material for the undergraduate curriculum was first undertaken by the Staff of the Department of Electrical Engineering we felt that this material should not merely fill the immediate needs of the undergraduate subjects for which it was primarily intended but in addition should offer stimulation and incentive for further study. For this reason occasional glimpses were afforded of the horizons which lie beyond the artificial boundaries set by conventional limitations in the treatment of technological principles. The collateral discussions engendered by these aims tended to appear digressive; moreover, they became so numerous as to interfere seriously with conciseness, continuity, and clarity. We therefore determined to relegate these supplemental treatments to an appendix. As the project developed the appendix became too large to justify itself; in fact, it took on the aspect of a text in itself. Thus evolved the concept of companion or reference volumes for collateral study.

Later, when we evaluated this concept as to scope and organization, we concluded that the supplemental material would be more useful if the discussions of a purely mathematical nature were collated and separated from the applications to be predicated thereon. This book is the result of this effort to avoid redundance and to attain a logical unification. The applications themselves, then, were to appear as further reference volumes of the series depending for their foundations on *The Mathematics of Circuit Analysis*.

In the course of these efforts war intervened. Through its exigencies there was an unprecedented acceleration of scientific and technological effort, compressing into a few years what normally would have taken decades to achieve. Necessarily the revision program was held in abeyance during this critical period with the result that the Department of Electrical Engineering is now reconsidering the course revision program and modifying its prewar plans. The basic series must be reappraised in the light of the vast wartime developments. This may well lead to the addition of material to the earlier basic texts. Moreover, there must be drastic reconsiderations of the supplemental volumes which will form extensions of the basic series and complement this particular reference volume. Since at the moment this book goes to press the Department is in the midst of reevaluating the extensive revision program, it is impossible here to make precise pronouncements either as to the character or

number of volumes to follow. Although thus far it has been the practice to publish the volumes of the series without naming collaborators, since the immediate volume came about largely through the inspiration of Professor Guillemin, and since it was written entirely by him under the trying pressures of war, it has been decided to recognize him as author.

As to the subject of this volume it may be well to emphasize that a mathematical textbook written by engineers is to be looked upon as an idea conveyor without claim to rigor. The discussions given herein should be regarded as being plausibility arguments rather than proofs. The primary purpose is to stimulate interest and lay a background of general understanding upon which the student may later build more carefully. In no wise therefore is the character of presentation here given to be looked upon as a substitute for the more formal rigorous treatment of the mathematician.

Although other books of this nature have been written, in the planning of this book we felt that a rather complete assemblage of mathematical topics, needed specifically or collaterally in the analysis and synthesis of electrical networks and in the attack on field problems related to transmission lines, wave guides, and antennas, was still outstanding. The opportunity to include more detailed discussions of certain topics heretofore given too little attention has been capitalized, we hope, to the advantage of student and researcher alike.

In the field of advanced algebra, for example, we believed that a discussion of determinants and matrices becomes ever so much more meaningful when coupled with the geometrical interpretations provided by the subject of linear coordinate transformations and the closely related discussion of quadratic forms. Thus the first four chapters of this book bring together a collection of topics in advanced algebra that form a closely interrelated mathematical unit, and an indispensable unit in the foundations of circuit theory or any other field of application dealing with vibrations or particle dynamics.

The fifth chapter, on vector analysis, is incorporated at this point since the geometrical and algebraic ideas involved are closely related to the foregoing material, and because the two-dimensional aspects of vector analysis and field theory are very helpful in lending physical clarity to numerous topics in complex function theory which is taken up next. Here there is considerably more detail than is to be found in existing textbooks for engineers on this subject. While the usual book for the most part is content to lay a nominal background for the methods of complex integration plus some notions about conformal transformations for field-mapping purposes, here it is our aim to provide a physical and geometrical feeling for the properties of complex functions adequate to meet diverse needs in the network synthesis field. The last two articles

in this chapter, for example, are specifically concerned with a detailed discussion of factors relevant to stability considerations and the properties of physical impedance functions.

The final chapter, dealing with Fourier series and integrals, stresses a number of items with which the engineer is especially concerned such as the convergence of Fourier series, the approximation properties of its partial sums, singularity functions and their properties, elementary transform properties, evaluation of inverse transforms through complex integration, and their approximate evaluation through use of the saddle-point method.

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