Problem Solving Made *Almost* Easy

A Companion to

Fundamentals of Electric Circuits

Charles K. Alexander
School of Electrical Engineering and Computer Science
Ohio University

Matthew N. O. Sadiku
Department of Electrical and Computer Engineering
Temple University

Boston Burr Ridge, IL Dubuque, IA Madison, WI New York San Francisco St. Louis
Bangkok Bogotá Caracas Lisbon London Madrid
Mexico City Milan New Delhi Seoul Singapore Sydney Taipei Toronto

McGraw-Hill Higher Education

A Division of The McGraw-Hill Companies

Problem Solving Made Almost Easy: A Companion to
FUNDAMENTALS OF ELECTRIC CIRCUITS
Charles K. Alexander, Matthew N. O. Sadiku

Published by McGraw-Hill, an imprint of the McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020.

2 3 4 5 6 7 8 9 0 BAW/BAW 0 9 8 7 6 5 4 3 2 1 0

ISBN 0-07-236144-1

http://www.mhhe.com

TABLE OF CONTENTS

Dedicated to our parents

Ken and June Alexander
&
Ayisat and Solomon Sadiku

PREFACE

Although this is designed to be a companion workbook for our text, FUNDAMENTALS OF ELECTRIC CIRCUITS, it is also designed to be an effective supplement to ANY circuits text. The primary focus of this workbook is to enhance problem-solving skills. This is complemented with many of the problems designed to aid students in developing a more robust understanding of fundamentals.

There are 300 problems with solutions in this workbook. They are organized in the same way our text is. The chapters are the same and the section topics are the same. There are 92 problems from our text (only odd numbered ones) that are worked in detail. These are noted by the actual problem number from our text in square brackets, italicized, e.g. *[10.43]*, following the workbook problem number. In addition, there are 24 problems worked to the level of the "PROBLEM SOLVING" process.

The "PROBLEM SOLVING" process was developed by us to aid students in developing a structured approach to problem solving. It is detailed at the end of this section.

One of the strengths of both the text and the workbook is that errata for both will be kept, real time, on the web. To find this, go to www.mhhe.com/alexander. If the student is not sure the answer is correct and there is no mention of an error in the errata, then the student can click on the email address for either of us and send an email to which we will respond as quickly as possible.

We have included some theory where appropriate to help the student with understanding. However, this is not meant to be instructional at the level of a textbook. We have also included a few problems where there are answers only. These

problems are similar to ones worked earlier in the chapter and the student is urged to look back in order to gain needed help when problems are encountered.

PROBLEM SOLVING

{a structured approach}

Although the problems solved during one's career will vary in complexity and magnitude, the basic principles to be followed remain the same. The process outlined here is the one developed by the authors over many years of problem solving with students, for the solution of engineering problems in industry, and for problem solving in research.

We will list the steps simply and then elaborate on them.

1. Carefully **DEFINE** the problem.
2. **PRESENT** everything you know about the problem.
3. Establish a set of **ALTERNATIVE** solutions and determine the one that promises the greatest likelihood of success.
4. **ATTEMPT** a problem solution.
5. **EVALUATE** the solution and check for accuracy.
6. Has the problem been solved **SATISFACTORILY?** If so, present the solution; if not, then return to step 3 and continue through the process again.

1. *Carefully **DEFINE** the problem.* This may be the most important part of the process, because it becomes the foundation for all of the rest of the steps. In general, the presentation of engineering problems is somewhat incomplete. You must do all that you can to make sure you understand the problem as thoroughly as the presenter of the problem understands it. Time spent at this point clearly identifying the problem will save you considerable time and frustration later. As a student, you can clarify a problem statement in a textbook by asking your professor to help you understand it better. A problem presented to you in industry may require that you consult several individuals. At this step, it is important to develop questions that need to be addressed before continuing the solution process. If you have such questions, you need to consult with the appropriate individuals or resources to obtain the answers to those questions. With those answers, you can now refine the problem, and use that refinement as the problem statement for the rest of the solution process.

2. ***PRESENT** everything you know about the problem.* You are now ready to write down everything you know about the problem and its possible solutions. This is another important phase that will save you time and frustration later.

3. *Establish a set of **ALTERNATIVE** solutions and determine the one that promises the greatest likelihood of success.* Almost every problem will have a number of possible paths that can lead to a solution. It is highly desirable to identify as many of those paths as possible. At this point, you also need to determine what tools

are available to you, such as PSpice, MATLAB, and other software packages that can greatly reduce effort and increase accuracy. Again, we want to stress that time spent carefully defining the problem and investigating alternative approaches to its solution will pay big dividends later. Evaluating the alternatives and determining which promises the greatest likelihood of success may be difficult but will be well worth the effort. Document this process well since you will want to come back to it if the first approach does not work.

4. ***ATTEMPT*** *a problem solution.* Now is the time to actually begin solving the problem. The process you follow must be well documented in order to present a detailed solution if successful, and to evaluate the process if you are not successful. This detailed evaluation may lead to corrections that can then lead to a successful solution. It can also lead to new alternatives to try. Many times, it is wise to fully set up a solution before putting numbers into equations. This will help in checking your results.

5. ***EVALUATE*** *the solution and check for accuracy.* You now thoroughly evaluate what you have accomplished. Decide if you have an acceptable solution, one that you want to present to your team, boss, or professor.

6. *Has the problem been solved* ***SATISFACTORILY?*** *If so, present the solution; if not, then return to step 3 and continue through the process again.* Now you need to present your solution or to try another "alternative." At this point, presenting your solution may bring closure to the process. Often, however, presentation of a solution leads to further refinement of the problem definition, and the process continues. Following this process will eventually lead to a satisfactory conclusion.

ACKNOWLEDGMENTS

Clearly in the preparation and publication of a manuscript, there are many individuals who deserve a lot of credit. The one we are most indebted to is Catherine Huitger, a colleague who has made significant contributions. In fact, if it were not for her, we could not have met our publication schedule.

We also appreciate the help, support, and most of all, patience of our McGraw-Hill staff. In particular, Catherine Fields was most helpful in helping pull all of this together.

We chose to dedicate this book to our parents. Individuals accomplish much in life; however, we have always believed in the fact that almost all the good we do can be traced back to our parents and how they interacted with us as we were growing up.

Finally, on a personal note, I wish to thank Matthew for coming to me several years ago and suggesting we write a textbook on circuits together. It has been a very professionally rewarding experience. In addition, I must acknowledge the outstanding support I have received from my department chair (*School of Electrical Engineering and Computer Science*), Dr. Dennis Irwin.