



**The Gateway to Understanding:  
Electrons to Waves  
and Beyond  
WORKBOOK**

**Matthew M. Radmanesh, Ph.D.**

**The Gateway to  
Understanding:  
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and Beyond  
WORKBOOK**

**Matthew M. Radmanesh, Ph.D.**  
Professor of Electrical  
& Computer Engineering,  
California State University,  
Northridge



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**Cover Illustration:** *The design on the cover shows the progression of concepts to application masses; a journey from the viewpoint (the sun), to postulates (the clouds), to fine energy particles (the dots), leading to waves (the radiated light), down to its condensation to solid matter (the mountains) and eventually arriving at the final end point: the panoramic physical universe in all of its aspects, spanning from the microscopic to the macroscopic universe-- ranging in size from an atom, to a device, to a circuit, to a satellite, to the earth, to the solar system, to the Milky Way galaxy and beyond.*

*Dedicated to  
the Educators and  
Skilled Practitioners of  
Modern Sciences  
Who Have Greatly Enriched  
Our Lives!*

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# Foreword

To "The Gateway to Understanding: Electrons to Waves and Beyond" Book

The study of electronic waves has been broken down into artificial subdivisions where most texts cover a small part of the subject mathematically while ignoring the rest. In our scientific community, there has been a need for a coherent, one-stop approach that covers the breadth of this material in a manner that allows a total comprehension of the subject. I believe this book finally fills this void by delivering this long-awaited material.

The field of electronic waves has not only had a profound impact on our scientific thinking and understanding of the universe around us, but has found numerous applications based on the mathematical sophistication of Maxwell's equations.

Most people in our highly automated society strive toward a meaningful understanding of the workings of electronic equipment and the major principles behind the fascinating form of energy called electricity and electronic waves. Most textbooks on the subject, however, ignore the basic concepts and introduce such a great deal of mathematical complexity that most students of science consider

the subject of electricity untenable. Professor Radmanesh has written this book with the hope of inspiring and enlightening those individuals who desire an understanding of the world of electricity based on a top down approach with no undue complexity.

It will become obvious to the reader, as it has to me, that this book is the result of many years of observation and codification of the physical universe with particular attention to a deep understanding of electronic waves. In this work the origin of our universe is examined and many novel principles are freshly and elegantly introduced.

The book begins by examining the scientific fundamentals and presents a solid understanding of the material universe and its three original postulates leading to four constituent components, which have paved the way to its numerous applications (Chapters 1- 3).

Chapters 4 through 9 present a panoramic view of waves based on major discoveries that took the world of sciences by surprise when they were first introduced in the nineteenth century. Electronic waves are clearly shown to be merely an example of how waves are part and parcel of this universe. With a unique approach, this book shows how to construct and handle any universe such as a technical universe or any component thereof such as waves.

Chapter 10 presents experimental proof of existence of waves, an important step in any scientific endeavor, where anything proposed must be proven. This is a remarkable step in the discovery of waves and Dr. Radmanesh has done a superb job in providing the reader with a clear understanding of what goes into making a successful hypothesis, along with accurate methods to perform scientific experiments to prove the hypothesis.

The subject of electronic waves has been a gateway to wireless networks, cellular phones, Global positioning system (GPS), Microwave Monolithic integrated circuits (MMICs), etc. The inventions and scientific developments in this and the last century provide a glaring testimony to this.

There are Eight supplemental discoveries, which are presented in Chapter 11 with an eye to their practical applications and how they can be used in the solution of actual problems dealing with different

aspects of electromagnetism. These supplemental discoveries help to obtain quick answers to many complicated technical problems facing the professionals in this fascinating field.

Chapter 12 treats the reader to a delightful discourse on the author's vision of what lies beyond the physical universe. It presents a stimulating view of what forms the make-up of any science and presents a clear view of our complex physical universe both on a classical as well as quantum mechanics level.

In Chapter 13, the author makes several concluding remarks in what he hopes will be helpful suggestions in bringing about a revitalization in thinking for scientists and engineers, and methods of education of current and future science students and/or inventors.

The basics are explained clearly and the powerful principles of electricity are expressed lucidly and dynamically, providing a keen impression in the reader's mind. It is written for technical as well as non-technical readers and should serve as a valuable resource for professional engineers, scientists, teachers, undergraduate/graduate students, interested but non-technical individuals, and technical managers.

The significance of this work lies in the manner in which it explores the fundamental postulates forming our universe and presenting them to the scientific community for the first time. Furthermore, the book makes a definite connection between the field of electricity and the broad aspects of our material universe, and does it with tremendous simplicity while making the reader aware of more intricate aspects of our sciences.

Finally, this book through its clarity and straightforward style of presentation provides the scientist as well as the non-technical individual an opportunity to appreciate the relationships between two seemingly unrelated universes: the “physical universe” and the “thought universe.”

**Dr. Asad M. Madni, CEng., FIEEE, FIEE, FAAAS, FNYAS, FIAE, FIBA**  
UCLA Alumnus of the Year Award, 2004

*President & Chief Operating Officer, BEI Technologies, Inc.*

# Preface

To "The Gateway to Understanding: Electrons to Waves and Beyond" Book

A few years ago the author published a popular text entitled "Radio Frequency and Microwave Electronics, Illustrated," which was well received by the scientific community and at the time it appeared that some of the main goals set forth by the author in writing the book were fulfilled. However, the main public who were not technically oriented or mathematically gifted did not instantly gravitate toward this work. Thus an attempt to present and bring about a general understanding of sciences, particularly the field of electronic waves, was begun.

Almost anyone in today's highly technological society strives toward a higher understanding of the inner workings of electronic equipment and desires to know the major principles behind this fascinating form of energy called electricity and electronic waves, and yet most electrical books present the basic concepts with so much complexity and filled with so many mathematical equations that the average public individual has given up on the subject and perforce has decided to retire to the sideline to be a spectator on the

subject. In other words, his hope has been dashed aside and his dream of a higher understanding has not been fulfilled in any of the modern texts on electricity.

Furthermore, the subject of waves, particularly electronic waves has been piecemealed to a point where every text covers only a small part of the subject and leaves the rest to someone else to develop. At the present moment there is no coherent and one-stop approach that covers this material from A to Z and presents it in such a way that average public can wrap their wits around it. There has been a need for such a text for quite sometime.

Over the last hundred years, the field of electronic waves, initially placed on a firm ground by Maxwell, has grown and blossomed magnificently, primarily in the area of applications to match up with the mathematical sophistication with which Maxwell's equations were presented.

The present work is the culmination of many years of study, observation, and pondering on the dilemmas and enigmas of propagating waves and their origin and the resultant understandings that was extracted from this sophisticated and at times incomprehensible field of study.

In preparing this book, the emphasis was shifted from sophisticated mathematical solutions and shifted to conceptual understanding of the material contained in the postulates and axioms of a science. Instead the complex mathematical equations have been transferred to the many appendixes in the back of the back. The emphasis has been aptly placed on workable postulates of physics and essential principles of electromagnetism and the related discoveries using simple concepts while emphasizing the basics all the way.

Throughout this book the reader will be delighted to find numerous examples of actual application mass that has been developed through the years by very bright minds and practitioners of this field. The focus is on some of the basic applications of the electromagnetics to many different fields of study including, electrical circuits, magnetic circuits, RF engineering, microwave systems, electronics and photonics.

It is an interestingly uncommon book written primarily for the technical as well as the non-technical man. It is intended to serve several classes of our society

- a) The professional engineers,
- b) The technical inventors,
- c) The technically versed individuals,
- d) The interested but non-technical individuals,
- e) The college professors,
- f) The business and industrial leaders,
- g) The college and university students,
- h) The professional scientists, and
- i) The Non-Engineers.

The book can be used for professional and practicing Engineers in the field, and business or industrial leaders, who are the visionaries of their group. It can also be used for inventors of new devices and gadgets. Most inventors would like to go to a source, where the initial spark of invention can be ignited. This book will surely serve as well this important class of our society—the technical Inventors.

For the average man who may or may not be technically versed and yet desires to learn about the universe at large, or the technical world in his immediate surroundings. It is intended to lift the aura of “black magic” surrounding the world of sciences particularly electricity, to enlighten and demystify the subject of sciences in the minds of ordinary individuals.

### **The Importance of Work**

Rather than looking into the complicated mathematical equations for solutions, Man's long search for answers to the riddles of the technical world will finally be amply rewarded through the pages of this book. By avoiding undue complexities, the reader will achieve occam's razor doctrine and will be actually traveling in the direction of “the actual why” and thus be able to put his thoughts on the right track for all the future problems forthcoming.

Within the confines of this book, one is given a chance for the first time to take an in-depth look and inspect firsthand, one of the most dynamic fields of study that has ever been developed in the history

of mankind on this planet. The basics are laid in simple terms and clear explanations express the powerful principles lucidly and dynamically, providing an unforgettable impression in the reader's mind.

The scientist, armed with the tools solidly laid out in this book, will be well equipped to understand scientific journals and handle the problems of work-a-day world of sciences, particularly testing, analysis, and design of devices, circuits, and systems dealing with electric, magnetic or electronic wave phenomena. The increased depth of knowledge will allow one to achieve one's objectives with a much higher probability of success in this rapidly advancing subject.

The broad importance of this work could be summed up as a totally new approach to understanding our scientific world through the use of newly discovered fundamentals (missing in all technical books), which add a tremendous amount of simplicity and clarity to very complex problems.

This is a new approach unmatched in any extant text today. The discovery of these fundamentals has had a huge impact on our current world and has truly made our scientific arena a bright beacon of hope with a renewed interest in understanding our physical universe. This work has created a “unified theory “about the physical universe in very simple terms.

*Finally, this work paves the way for the scientist as well as the non-technical individual to formulate and develop a relationship between two distinct universes: the “Material or Physical Universe” and the “Universe of Thought”.*

## **The Scope of Work**

The current work can be used to serve as a textbook for a course in physics, electromagnetics, RF electronics, microwave Engineering and the advancing field of photonics. It is intended for all levels of college particularly for senior-level or graduate students. It can just as well serve as an excellent reference guide for the professional scientist, practicing engineer, whether in electromagnetics, RF and

microwaves, electro-optics, or general sciences who is actively involved in his/her respective field.

The book starts from the very general postulates, considerations and laws and presents an example of these principles with the introduction and evolution of the universe of electronic waves. The book, divided into four parts and 13 chapters, presents these chapters with the progressive development of concepts following the same pattern as presented in the pyramid of knowledge in Chapter 1, which is:

**A) PART I- THE PHILOSOPHICAL FOUNDATION OF SCIENCES**

Chapters 1-3: Present a framework for any science and analyze the physical universe by putting forth the three original postulates and the derived primary postulates that created it. Moreover, the workable postulates of physics are discussed in depth and through introduction of the hidden and implicit postulates, the potential pitfalls of the subject are exposed.

**B) PART II- ELECTRONS TO WAVES: THE MONUMENTAL DISCOVERIES**

Chapters 4-6: Present the progressive development of electricity and magnetism and state the three monumental discoveries that brought them to the forefront of technology.

Chapters 7-9: Deal with the final saga of electromagnetism as a unified science, as it was discovered and how it came to its full fruition.

Chapter 10: Introduces the experimental proof of waves and shows conclusively the existence of waves. This was the crowning moment for Maxwell and his wave theory, who predicted the existence of waves long before its discovery.

Chapter 11: Introduces the supplemental discoveries, which help to fill the gaps of knowledge in

electromagnetism and to elucidate those subordinate concepts, which were not touched upon in the previous chapters.

### **C) PART III- THE FUTURE AHEAD**

Chapters 12-13: Discuss what lie beyond the current universe and presents a summary of the basic scientific considerations that underlie all of our current sciences and technology. It also points out to the universe ahead and what would the future bring at the current pace of scientific developments.

### **D) PART IV-APPENDICES**

A list of symbols used in each chapter and a series of quizzes are included at the end of each chapter to aid the reader gain a fuller understanding of the presented materials. The book ends with a glossary of technical terms and several important appendices. These appendices cover physical constants and other important data needed in the process of understanding of the material covered in the text.

## **The Author's Goals**

As part of the author's goals, the presentation of a number of scientific fundamentals pours the foundation for understanding our complex universe particularly the universe of waves. They provide a rather deep philosophical bed-rock upon which the weight of the rest of the ensuing complicated concepts can be supported.

Moreover, with the help of this foundation, the author intends to achieve several milestone achievements:

- a) *Create a better perspective toward application of sciences especially electricity and electronic waves,*
- b) *Promote a better and deeper understanding of the scientific methodology, and how it is used to achieve stellar results in the scientific arena,*
- c) *Bring about a public awareness of sciences and how the universe of waves affects us in many ways on a constant*

*basis and how a simple knowledge of the subject leads to a plethora of applications.*

The full “pyramid of knowledge,” pertaining to the field of waves, has been streamlined and presented in a simple language. This missing element (pyramid of knowledge) from the field of science and engineering as well as education has created a truncated science where the top half of this pyramid is cut off. This vital amount of information missing from any subject invites disaster for its students and followers. It would surely create great turmoil in the minds of people associated with sciences (e.g. students, educators, designer, etc.) all over the world. The brief presentation of these basics in this chapter is expected to bring about nothing but a small renaissance in the scientific arena as a whole particularly in the field of waves, electricity and magnetism which are rapidly advancing fields.

The tools used by the pioneers and founders of sciences are the tools of today’s successful scientists, who strive to succeed in their profession. By knowing these materials well, the reader will be taking the same route that all the great men and women of sciences took to achieve their remarkable discoveries that we are all benefiting from.

The non-technical reader will be invited to examine a series of basic materials that will enable him/her to understand his immediate universe far better than ever before. He/she will be exposed to materials of considerable significance, which surely would open up the gates of knowledge along with a wider horizon of understanding.

For professional engineers or science students who are armed with these tools as their stock-in-trade, they are equipped well to understand scientific journals and handle the problems of work-a-day world of sciences, particularly analysis and design of devices, circuits and systems dealing with electric, magnetic, electronic waves, etc. Their depth of knowledge will allow them to achieve their objectives with a much higher probability of success in this magnificent arena.

Matthew M. Radmanesh, Ph.D.

## Acknowledgements

First and foremost, special thanks are due to Dr. L. Ron Hubbard, whose writings, whether fiction or non-fiction, inspired the author to write the original manuscript of the book and then the current workbook, which makes learning more practical. It helped to ignite the initial spark of realization of how sciences connect with the universe of thought and how they are actually a smaller subset of a much larger sphere of activity called life and livingness. Thus, a quest for the answers of a puzzle of enormous proportion, i.e. electricity, was begun.

The author also wishes to thank many of his undergraduate and graduate students spanning twenty years (1984-2004), who with their inquisitive minds, propelled the author to revise the first manuscript of this work in order to answer some of their questions.

Moreover, amongst many the author is grateful to Jeff Quin of Litton Guidance Center whose assistance in many ways was invaluable. Special thanks to Dr. Myungkul Kim, a great microwave student and friend, who made many invaluable suggestions to the first

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Matthew M. Radmanesh, Ph.D.  
Dept. of Electrical and Computer Engineering,  
California State University, Northridge,  
April 2005

**Part One**

**The Essentials**

# 1

## How to Learn Sciences

### **THE IMPORTANCE OF CORRECT EDUCATION**

Education in the science of physics, engineering, electronics and others consists of guiding the reader along a gradient of known data, with the highest attention to the basic concepts that form the foundation of any of these desired fields of study.

The basic concepts presented in this book are far more fundamental than the mother sciences of engineering (i.e., physics and mathematics) and cover the essential truth about our physical universe in which we live. These basic truths convey a much deeper understanding about the nature of the physical universe than has ever been discussed in any electronic or for that matter any scientific textbook.

These basic truths set up a background of discovered knowledge by mankind, against which a smaller sphere of information (i.e., electricity, electronic engineering, physics, etc.) can be examined. Many of the principles, which appear in technical books, are easily describable and thus understood much better once the basic underlying concepts are grasped.

In general, we can see that workable knowledge is like a pyramid, where from a handful of common denominators efficiently expressed by a series of basic postulates, axioms and natural laws, which form the foundation of a science, an almost innumerable number of devices, circuits, and systems can be thought up and developed.

The emphasis is on fundamentals and for this reason all new technical terms must be thoroughly defined and understood as they are introduced. This is a novel approach and is based upon the results obtained in recent investigations and research in the field of education, which has shown that the lack of (or the slightest uncertainty on) the definition of terms will pose as formidable obstacles in the reader's mind in achieving full comprehension of the material.....

# Glossary of Technical Terms

The following glossary supplements the presented materials in the text, but does not replace the use of an unabridged technical dictionary, which is a must for mastery of sciences.

## A

### **Absolute**

a) That which is without reference to anything else and thus not comparative or dependent upon external conditions for its existence (opposed to relative), b) That which is free from any limitations or restrictions and is thus unconditionally true at all times.

### **Absolute Temperature Scale**

A scale with which temperatures are measured relative to absolute zero (the temperature of  $-273.15\text{ }^{\circ}\text{C}$  or  $-459.67\text{ }^{\circ}\text{F}$  or  $0\text{ K}$ ). The absolute temperature scale leads to the absolute temperatures, which are: a) The temperature in Celsius degrees, relative to  $-273.15\text{ }^{\circ}\text{C}$  (giving rise to the Kelvin scale), and b) The temperature in Fahrenheit degrees, relative to  $-459.67\text{ }^{\circ}\text{F}$  (giving rise to the Rankine scale). At absolute zero temperature, molecular motion theoretically vanishes and a body would have no heat energy. The absolute zero temperature is approachable but never attainable. *See also temperature.*

### **Active Device**

An electronic component such as a transistor that can be used to produce amplification (or gain) in a circuit.

## An Indispensable and Practical Companion to

### *"The Gateway to Understanding: Electrons to Waves and Beyond" Book*

"This is an invaluable book to anyone who aspires to understand the complicated world of sciences, particularly electricity, electronic waves and what lies beyond....."

*Dr. Asad M. Madni, IEEE Fellow, IEE Fellow, CEO/COO of BEI Technologies, Inc.*

"This book transcends Stephen Hawking's 'A Brief History of Time,' and takes off where it was left off."

*The Gateway to Understanding:.....*

"This book, if applied, will bring about a renaissance in sciences and will change their course of development and path of evolution forever."

*Dr. Matthew M. Radmanesh, Professor of Engineering, CSUN*

#### Features

- a) *A step by step approach presenting a series of lessons, which are bite-sized pieces of information taken from the book.*
- b) *The lessons act like a trail or a "road to knowledge" with a definite beginning and a finite end. This prevents possible frustration of the reader from aimlessly reading the book or getting overwhelmed by the enormity of the subject.*
- c) *Solutions to the many end of chapter quizzes provide an excellent check-out to the reader's comprehension of the materials.*
- d) *A streamlined approach to learning electricity/electronics, which takes irrelevant materials off the direct path of achieving the final goal of total comprehension; thus bringing simplification to a very complicated subject.*

#### Intended Audience

The workbook is intended for the practicing engineer, the professional scientist or any individual who desires a workable knowledge and intuitive understanding of electricity, electronics and the secrets of our complex world.

**Matthew M. Radmanesh, Ph.D.**, is currently a faculty member in the electrical and computer engineering department at California State University, Northridge, CA. Dr. Radmanesh is a senior member of IEEE, Eta Kappa Nu Honor society and a past president of the SFV chapter of the IEEE Microwave Theory and Technique (MTT) society. He holds two patents for his pioneering work in millimeter-wave solid state noise sources.



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