INTRODUCTION TO PRACTICAL RADIO

DURWARD J. TUCKER, B.S. in E.E., E.E.

Chief Radio Engineer, WRR, KVP, KVPA
Member, American Institute of Electrical Engineers
Senior Member, Institute of Radio Engineers
Member, National Society of Professional Engineers

THE MACMILLAN COMPANY · NEW YORK

PRINTED IN THE UNITED STATES OF AMERICA

Fourth Printing, 1953.

Preface

Radio is such an extensive subject that it would require many volumes to cover it thoroughly. Such an undertaking would be a tremendous task and no such set of books has been written, although there are many covering its various phases.

The author has long felt the need for a single text dealing with the basic fundamentals of radio that could be used as a steppingstone to more advanced books on the subject. This text was written with that thought in mind. No attempt has been made to cover the whole subject of radio but rather to limit the text to the initial principles that any student must first learn before he takes up the more advanced phases.

By confining the text material to first principles, the author has been able to cover each step adequately. In addition, the necessary mathematical tools are supplied as needed, in the belief that they will be of material aid to those lacking the prerequisites necessary to study most radio texts.

It is hoped that more advanced students will find the book an extensive reference and an invigorating "refresher" in relearning the many fundamental details.

The author wishes to express his appreciation to Dean E. H. Flath of the Southern Methodist University Engineering School, to Walter J. E. Schiebel, Director of the Dallas Public Evening School, and to many others, too numerous to mention, for their constant encouragement and many helpful suggestions. He is likewise indebted to his many students and other friends for the answers to the problem exercises and for detailed work in checking several chapters of the manuscript.

The author is deeply indebted and grateful to his wife for typing the manuscript and for her many suggested improvements.

DURWARD J. TUCKER

Symbols Used in Text

A	Cross-sectional area
a-c	Alternating-current
B	Flux density
C	Capacitance
d-c	Direct-current
e	Instantaneous voltage; also, Napierian system base where e = 2.71828.....
E	Voltage
E_{eff}	Effective voltage
E_{max}	Maximum voltage
f	Frequency
F	Magnetomotive force measured in Gilberts
H	Magnetizing force in Oersteds
i	Instantaneous value of current
I	Current
I_{eff}	Effective current
I_{max}	Maximum current
k	Coefficient of coupling between two coils
K	Constant determined by the properties of the magnetic material; also, dielectric constant of a condenser dielectric
l	Length
L	Inductance
M	Mutual inductance between two coils
N	Number of turns in a coil
p	Instantaneous power
P	Electric power
P_{avg}	Average power
P_h	Hysteresis core loss in watt-seconds per cubic centimeter per cycle
P_{max}	Maximum power
R	Resistance in ohms
$\mathcal{R}$	Reluctance
t	Thickness of dielectric
W	Watts (unit of electrical power)
W_h	Hysteresis core loss in watt-seconds per cubic centimeter per cycle

x	Horizontal axis
X	Reactance
X_C	Capacitive reactance
X_L	Inductive reactance
y	Vertical axis
Z	Impedance
$=$	Equal sign
$\neq$	Unequal sign
[]	Brackets
{}	Braces
$\sqrt{\ }$	Radical sign
ϕ	Total number of lines of force (Maxwells)
μ	Permeability
π	Ratio of Circumference of circle to Diameter (3.1416.....)
ρ	Resistivity of metallic conductor
∞	Infinity

INTRODUCTION TO PRACTICAL RADIO

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CHAPTER I *Introduction*

1. Relation to Electricity. The first thing that the student of radio must realize is that radio is not a separate science apart from electricity. Actually, it is but a specialized subject of electricity. To understand radio fully, one must first fully master the fundamentals of electricity.

It may seem to the student just starting the study of radio that the time and space in this text devoted to the study of the elements of electricity is excessive. Especially may this be true where the student has already covered the material in other texts. So much in radio depends upon a thorough knowledge of the fundamentals of electricity, however, that this material should be an excellent review for those who have studied it before and provide a suitable foundation in electricity for those covering it for the first time.

It is a waste of time to try to learn radio without first acquiring some knowledge of the basic principles underlying electricity. These are the abc's of radio, and the student must fully understand each one before progressing to the next. No attempt has been made to "pad" the text. Only those parts of electricity that are used over and over again are included.

2. Building Stones of Radio. Many believe that radio is quite difficult to learn and beyond their ability. In most cases, this can be traced to an improper approach to the subject. Here again is an example of why *first things must come first.* Lack of knowledge on the part of the student as to what to study first and how to choose from the maze of radio texts available contributes to his confusion.

The student will soon find that radio has many building stones fashioned from three principal sources: namely, resistance, inductance, and capacitance. These three quantities may be compared to wood, brick, and cement used extensively by the building industry. One knows that many building materials are formed from these basic

substances. Likewise, many circuit elements are formed from resistance, inductance, and capacitance. The student will find a generous supply of pictures throughout the book showing many typical radio parts. These should be of material assistance in helping the student familiarize himself with the many different pieces of radio apparatus.

3. Mathematics. Students are often concerned with what knowledge of mathematics will be required in the study of radio.

There is no doubt that the use of mathematics is very helpful in acquiring a full understanding of radio principles. The choice of the kind of mathematics and the extent to which it is used in a text should be governed by the text material and the student. Naturally, as the student progresses farther and farther into the subject of radio, a greater knowledge of mathematics will be required.

The author has striven to keep in mind that this is a course in radio and not one in mathematics. The author is a firm believer in setting down the material, not only in the simplest mathematical form, but also in the plainest language possible.

Only those phases of mathematics deemed absolutely necessary are included in this text. They are placed, like the workman's tools, at the student's side at the right points in the book where he will need them. No attempt has been made to make the mathematical sections complete from a mathematical standpoint. Only enough mathematical material for a proper understanding of the radio material is included.

4. Examples and Problems. Numerous examples are included in order to familiarize the student fully with the principles involved.

Problem exercises have been inserted as near the theoretical treatment of a subject as possible. The student should solve these problems and be sure that he understands each section before passing on to new material. Answers are provided at the end of each chapter for the convenience of the student in checking his work since, in many instances, the text will be self-taught.

5. Conclusion. Study and experience in radio as a professional Radio Engineer and as a teacher, have taught the author that *there is no "short cut" to learning radio.* The student will do well to profit by this experience if he is to master the subject of radio most effectively in the shortest possible time.

At this point, the student is most likely to ask: "For what will this text prepare me?" This is a pertinent question but one which is difficult to answer. Many, beginning the study of radio are surprised, confused, disappointed, and discouraged that all the secrets of radio cannot be found between the two covers of one book. Many visualize the study of radio in the same light as the study of typing, shorthand, bookkeeping, and other business courses. They visualize progress in Radio Engineering as easy as gaining speed from week to week in typing. Such thoughts are not of Radio Engineering, but are of radio mechanics or a "screw-driver and pliers" knowledge in radio. The mechanics of testing and changing tubes, setting up amplifiers, learning the technique of soldering and wiring, making replacements of charred and burned parts and other similar mechanical details can be learned within a few weeks. This is a most essential part of the radio industry but should never be confused with the Radio Engineering Profession.

The author has started at the very beginning and has striven to make the text *complete within itself* in order that the student may acquire a firm foundation in the fundamental principles of radio without having to refer to other texts for additional material. After finishing the text, the student should have acquired sufficient knowledge to take up the study of other books dealing with the more advanced phases of radio.

REVIEW QUESTIONS

1. Why is an understanding of the basic principles of electricity necessary in order to learn radio?

2. Is a thorough knowledge of mathematics helpful in the study of radio? Why?

3. What are the advantages of providing the proper mathematical tools along with the radio material?

4. Why are problem exercises helpful in the study of a subject such as radio?

5. Compare the study of radio to the study of typing, radio code, and riveting.

CHAPTER II *Elementary Electricity*

6. Introduction. The engineering development of electrical equipment, since the turn of the century, has done much to add to the comfort of man. Many new branches of electricity have been developed. Radio is one of these, and its development has added much to the present knowledge of electricity.

Despite the wealth of knowledge of the behavior and characteristics of electricity, its exact nature is not too well defined. One may be surprised to learn that electricity is a part of matter itself.

7. Molecule and Atom. One is not accustomed to think in terms of units as small as the *molecule* or *atom* or their relation to matter, but in order to understand electricity better, it is necessary to go this far and farther. Matter is best known from many common materials, such as wood, linoleum, and cotton. Each material is determined by the *character of the molecules* of which it consists. Matter can be broken up into still smaller particles. The molecule can be broken down into *atoms. Two or more atoms are required to form a molecule.*

The many thousands of types of matter are formed from less than one hundred substances called *elements. The smallest unit of an element is an atom.* The structure of the atom determines whether matter is iron, gold, silver, or some other element. If the structure of the atom could be readily changed, then one element could be made into another, such as changing iron to gold. No such set of conditions exists. The atom vigorously opposes any attempt to break it up into smaller parts.

8. Electron. Scientists have been able to find out many things about the actual structure of the atom. Principle of these is that all atoms are composed of positive and negative charges of electricity. *Positive* charges of electricity are called *protons* and *negative* charges of electricity are called *electrons.* The number of positive and negative parti-