

FUNDAMENTALS OF MICROWAVE AND RADAR ENGINEERING

For Students of B.E./B.Tech.



Er. K.K. SHARMA



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**FUNDAMENTALS
OF
MICROWAVE AND RADAR
ENGINEERING**

FUNDAMENTALS OF MICROWAVE AND RADAR ENGINEERING

**For B.E./B.Tech. Students of Electronics & Communication
Engineering as per All Indian Technical Universities**

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Lingaya's University

Faridabad



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*This book is dedicated
to
my GURU JJ*



*Ananth Sri Vibhushit Indraprasth
and Haryana Peethadheeshwar
Srimad Jagadguru Ramanujacharya
Swami Sri Sudarshanacharya Ji
Maharaj*

PREFACE

In the recent years microwaves are being used in radar system, satellite communication, broadcasting of Television signals, astronomic research and in many applications in industry. This book **Fundamentals of Microwave and Radar Engineering** is intended to be used as a textbook that relatively covers all topics to the subject at undergraduate and postgraduate engineering levels. The fundamental concepts of microwave engineering are explained in a simple manner. Although the subject of Microwave and Radar Engineering is of particular interest to the specialists in that field, it is also of interest to persons, especially the military and civilian users of radar, satellite and navigational systems.

The author has 20 yrs of vast exposure on different types of radar system used in Indian Air Force as well as at the civil Airports. The author also has teaching experience at Air Force Technical College, Bangalore and has experience of installation and commissioning of radars.

The book has been written in a very simple language keeping in focus the syllabi prescribed for the subject in different institutions and universities. All the topics of this book has been illustrated with the photograph and solved problems. The students preparing for the examinations can understand the concept in a better way by doing the solved and unsolved problems at the end of each chapter. Although utmost care has been taken to minimize the errors, author expect from the readers to provide feedback so that in future edition this book will be more useful.

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Er. K.K. Sharma

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1

CHAPTER

INTRODUCTION TO MICROWAVE

OBJECTIVES

- Introduction
- Brief History of Microwave Technology
- Microwave Frequencies
- Characteristic Features of Microwave
- Advantages of Microwaves Over Low Frequencies
- Applications of Microwave

1.1. INTRODUCTION

Microwave is the electromagnetic (EM) wave spectrum in the frequency range from 1 GHz to 100 GHz. In other words, the wavelength of EM waves at microwave frequencies is very small; typically from 30 cm to 0.3 mm. Sometimes higher frequencies (extending up to 600 GHz) are also called ‘microwaves’. Before discussing the principles and applications of microwave frequencies, the meaning of the term microwave as it is used in this book must be established. On the surface, the definition of a microwave would appear to be simple because, in electronics, the prefix “micro” normally means a millionth part of a unit. Micro also means small, which is a relative term, and it is used in this sense in the book. Microwave is a term loosely applied to identify electromagnetic waves above 1000 megahertz in frequency because of the short physical wavelengths of these frequencies because of the short physical wavelengths of these frequencies. Microwaves present several interesting and unusual features not found in other portions of the electromagnetic frequency spectrum. These features make ‘microwaves’ uniquely suitable for various useful applications. Small antennas and other small components are made possible by microwave frequency applications.

1.2. BRIEF HISTORY OF MICROWAVE TECHNOLOGY

The scientists of nineteenth century laid the foundation of communication using RF wave and wire less technology, which has affected modern environment. In 1845 Michel Faraday observed the effect of magnetic field on the light propagation. In the year 1864, James. C. Maxwell developed the four basic equations of electromagnetic theory of light. He put forth fundamental relation of electro magnetic field and also summed up the research observations of Poisson, Laplace, Faraday and Gauss. He also predicted about the propagation of electrical signals in free space. In 1893, Heinrich Hertz subsequently verified (by conducting an experiment) to show that a parabolic antenna fed by an element i.e. dipole on excitation by a spark discharge, sends a signal to an identical receiving arrangement at a distance. G. Marconi transmitted wireless signals across the Atlantic Ocean successfully. William Thompson developed the wave-guide theory and the mode properties of propagation through hollow metallic wave-guide.

The development in this field still continues and interested readers may find more information in the IEEE transaction on microwave theory and techniques (vol-MTT-32, SEPTEMBER 1984).

1.3. MICROWAVE FREQUENCIES

Table 1.1 and 1.2 shows the IEEE frequency based designation and microwave frequency band designation respectively.

Figure 1.1 shows the EM spectrum with the main applications.

Table 1.1. IEEE frequency based designation

<i>Band Designation</i>	<i>Frequency Range</i>	<i>Wavelength Range (in Free Space)</i>
LVF	3 – 30 kHz	10 – 100 km
LF	30 – 300 kHz	1 – 10 km
MF	300 – 3000 kHz	100 m – 1 km
FH	3 – 30 MHz	10 – 100 m
VHF	30 – 300 MHz	1 – 10 m
UHF	300 – 3000 MHz	10 cm – 1 m
SHF	3 – 30 GHz	1 – 10 cm
EHF	30 – 300 GHz	0.1 – 1 cm

Table 1.2. Microwave Frequency based designation

Frequency Bands	Old	New
500 – 1000 MHz	L	C
1 – 2 GHz	S	D
2 – 4 GHz	S	E
3 – 4 GHz	S	F
4 – 6 GHz	C	G
6 – 8 GHz	C	H
8 – 10 GHz	X	I
10 – 12.4 GHz	X	J
12.4 – 18 GHz	Ku	J
18 – 20 GHz	K	J
20 – 26.5 GHz	K	K
26.5 – 40 GHz	Ka	K

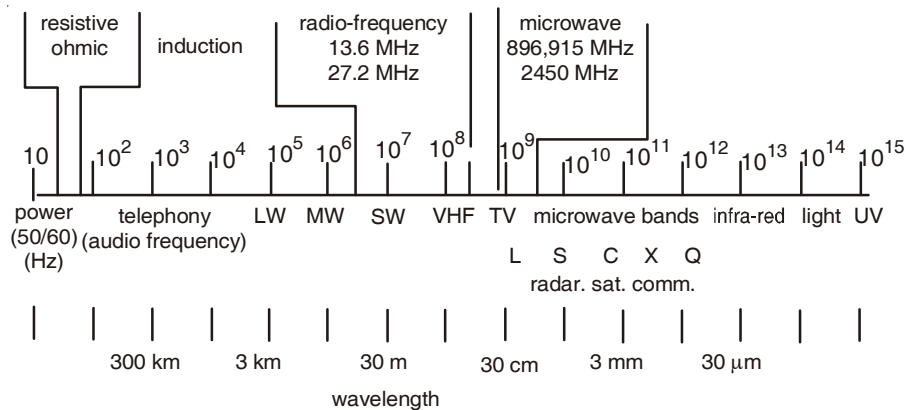
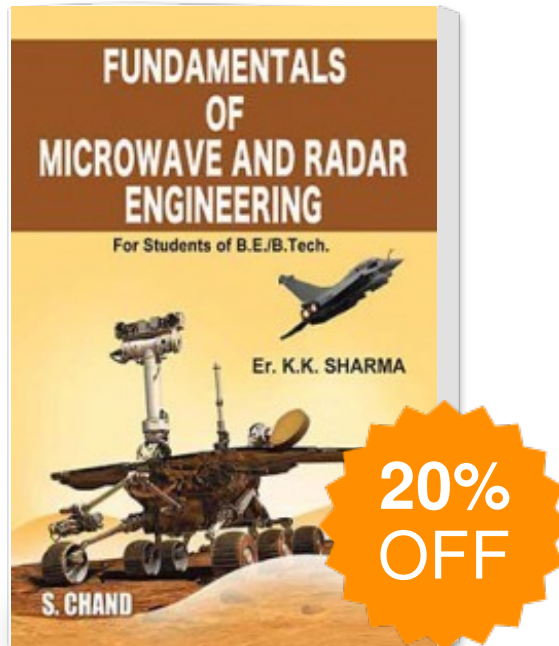


Fig. 1.1. The Electromagnetic Spectrum.

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