Wireless Communication

Incorporation of wireless technologies into any communication system enhances its flexibility and mobility. A proper understanding of wireless systems requires knowledge of fundamentals including modulation, coding, spreading, diversity and resource allocation techniques along with an understanding of antennas and propagation characteristics. Thoughtfully crafted for undergraduate and graduate students of electronics and communication engineering, this text book discusses all these fundamental topics elaborately and in a student friendly manner. It also covers design requirements, spectrum allocation and processes involved in popular wireless systems like cellular mobile systems, wireless data service and satellite systems. Discussions on generations of cellular mobile including 2G, 2.5G, 3G, 3.5G, 3.6G and LTE standards are included in greater detail. Advanced topics like turbo coding, smart antenna, Multiple Input Multiple Output (MIMO) system, Software Defined Radio and Cognitive Radio are also covered to keep the reader updated.

The concepts are elaborated and supported by plenty of illustrations, solved examples, points to remember, review questions and multiple choice questions. Other useful features of this book include glossary of important definitions, open book exam questions with hints, model question papers with hints, and an additional database of multiple choice questions, with answers.

Arumita Biswas works in the Cellular Mobile Telephone Service department of Bharat Sanchar Nigam Limited, a leading telecommunication service provider in India, where she supervises and maintains the core network entities of GSM and 3G network. She has published at various conferences organized by IEEE, with one paper receiving the best research paper award. Her current area of research is linked to LTE antenna design.

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Theory and Applications

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University Printing House, Cambridge CB2 8BS, United Kingdom
One Liberty Plaza, 20th Floor, New York, NY 10006, USA
477 Williamstown Road, Port Melbourne, vic 3207, Australia
4843/24, 2nd Floor, Ansari Road, Daryaganj, Delhi - 110002, India
79 Anson Road, #06–04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781316628362

First published 2017

Printed in India

A catalogue record for this publication is available from the British Library

ISBN 978-1-316-62836-2 Paperback

Additional resources for this publication at www.cambridge.org/9781316628362

To my parents Sh. Arup Ratan Biswas and Smt. Namita Biswas

— Arumita Biswas

To all my Teachers

— Mainak Chowdhury

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Preface

Communication industry is one of the fastest growing industries all over the world. Since its introduction, the system components have evolved dramatically. Owing to this rapid change/enhancement in technologies, the study of communication principles and systems is extensive and skills in this field are in high demand. Incorporation of wireless technology in any communication system provides added advantages in terms of flexibility and mobility. Wireless voice and data services are fast replacing their wired counterparts. Several researchers have contributed in this domain and with every passing day, new information is being added to this vast pool.

Topics covered

The authors have endeavoured to include a large number of topics on wireless communication in a single book. The book has been divided into two parts. Chapter 1 to 6 explain the fundamental principles and basics used for designing any wireless system, whereas chapters 7–12 throw light on popular wireless systems. Chapter 1 provides an overview of the wireless system highlighting topics like advantages and challenges of wireless communication, functional blocks that make up the transmitter and receiver entities in the wireless system and frequency allotment techniques used to avoid inter and intra system interference. The chapter ends with a discussion on generations and standards proposed for popularly employed wireless communication systems.

In any wireless system, the transmission of user information is done through the air interface which is prone to eaves-dropping, noise and interference. Besides, the transmission bandwidth allocated to every wireless user is only a small portion of the available spectrum. In order to make the transmitted signal favourable for transmission, some processing of user generated baseband signal is essential. Chapter 2 and 4 include a

detailed discussion on the various speech coding; channel coding, equalization, diversity, modulation and spreading techniques.

Each wireless system is allocated a fixed part of the available frequency spectrum for communication purpose. The users registered to a wireless system are allocated a part of this fixed frequency on a permanent or demand basis. A proper planning of the otherwise limited spectrum is essential in order to avoid congestion and interference. Chapter 3 on resource allocation technique provides a detailed discussion on the different multiplexing, duplexing and access techniques.

Wireless communication systems use radio waves for exchanging information between two entities. Antennas are thus an integral part of any wireless system design because this entity can convert RF signals over a guided medium into radio waves. Chapter 5 focuses on the basic parameters of antenna with design requirement and consideration. Once the radio waves are transmitted from the transmit antenna, they propagate from source to destination over an air interface. Different propagation characteristics determine the flow of signal. Chapter 6 gives a detailed description of wave propagation characteristics and models.

Part two of the book comprising Chapters 7 to 12 explains the popularly used wireless system. Cellular telephone system is the most popular wireless system solution with a user base of about billions around the globe. Although initially designed for providing voice service, it has expanded to provide voice, video and data service to the registered subscribers. Due to ever increasing demands of subscribers, this system has evolved through several generations of standards. Chapters 7 to 10 explain the system architecture, function of the network element, call flow diagrams, function of radio channels and key technologies linked with cellular system standards from the second generation to LTE (Long Term Evolution). Systems for providing wireless data service are fast replacing wired counterparts. Concepts on Wireless Local Area Network [WLAN] have been covered in Chapter 11 of the book. In order to provide global coverage, satellite system is designed. Chapter 12 explains the laws and principles governing satellite system design and working of Global Positioning System.

Appendix on topics like Software Defined Radio, Cognitive Radio, trunking theory, sensor network and planar antenna design have been included to make readers aware of the latest advancements in the field.

Features

The theoretical concepts in the book are supported with over 200 illustrations. These self explanatory illustrations will help in easy understanding of the topics covered. The text has been prepared after doing extensive research in this field — at the end of the book, a list of references is included. The interested reader can go through them for a better grasp over the wireless domain. Each chapter includes solved numericals, multiple choice questions and long questions for self examination. The salient points included can be used for last minute revision of the chapters. At the end, the book includes a database of over 100 open book questions, over 100 extra MCQ with answers, model question papers with hints

and a glossary of definitions, which can be useful for further testing the readers' understanding of concepts defined within.

Intended Readers

Along with the fundamental concepts of wireless communication, this book describes in detail the design of wireless system and their standards. It also covers advanced topics linked with HSUPA, HSDPA, LTE, MIMO, smart antenna, Software Defined Radio, Cognitive Radio and sensor network. Bridging the gap between fundamentals and the latest advancements, this book will serve as a complete guide in the wireless communication domain. The materials covered will not only be helpful for readers of undergraduate and postgraduate studies who wish to familiarize themselves with the concepts but also for professionals and training institutes wishing to conduct courses on wireless communication.

Acknowledgments

I take this opportunity to express my sincere gratitude to the team of Cambridge University Press including Rajesh Dey, Manish Choudhary, Rachna Sehgal and Hardip Grewal, who gave me the opportunity to work with them in this project. I extend my sincerest thanks to my co-author, Mainak Chowdhury for coordinating and striving hard to complete the project in stipulated time. I gratefully thank my parents, Shri. Arup Ratan Biswas and Smt. Namita Biswas for bearing with my odd late night writing schedules. I extend my thanks to my PHD guide Dr. Vibha Rani Gupta, HOD of ECE department at BIT Mesra for her ever extending support. I take this opportunity to thank new entrant in my life, my husband Suman Chakraborty for his motivations. I extend my thanks to all my teachers for enriching me with their knowledge at different stages. I wish to thank my colleagues, in-laws, friends and relatives for providing moral support. And above all I thank God for showering His blessings on me.

— Arumita Biswas

I gratefully thank the members of the Cambridge University Press team, Rajesh Dey, Manish Choudhary, Rachna Sehgal and Hardip Grewal, for their interest in this project. I am thankful to my co-author Arumita Biswas, who worked a lot to complete this book. I extend my thanks to Sabyasachi Tiwari for assisting me with his endless efforts. I am proud of my bright and energetic students and I bless them. I thank my family for providing support in all situations.

— Mainak Chowdhury