CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

PROBABILITY AND RANDOM PROCESSES FOR ELECTRICAL AND COMPUTER ENGINEERS

The theory of probability is a powerful tool that helps electrical and computer engineers explain, model, analyze, and design the technology they develop. The text begins at the advanced undergraduate level, assuming only a modest knowledge of probability, and progresses through more complex topics mastered at the graduate level. The first five chapters cover the basics of probability and both discrete and continuous random variables. The later chapters have a more specialized coverage, including random vectors, Gaussian random vectors, random processes, Markov Chains, and convergence. Describing tools and results that are used extensively in the field, this is more than a textbook: it is also a reference for researchers working in communications, signal processing, and computer network traffic analysis. With over 300 worked examples, some 800 homework problems, and sections for exam preparation, this is an essential companion for advanced undergraduate and graduate students.

Further resources for this title, including solutions, are available online at www.cambridge.org/9780521864701.

JOHN A. GUBNER has been on the Faculty of Electrical and Computer Engineering at the University of Wisconsin-Madison since receiving his Ph.D. in 1988, from the University of Maryland at College Park. His research interests include ultra-wideband communications; point processes and shot noise; subspace methods in statistical processing; and information theory. A member of the IEEE, he has authored or co-authored many papers in the *IEEE Transactions*, including those on Information Theory, Signal Processing, and Communications.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

PROBABILITY AND RANDOM PROCESSES FOR ELECTRICAL AND COMPUTER ENGINEERS

JOHN A. GUBNER
University of Wisconsin-Madison

CAMBRIDGE
UNIVERSITY PRESS

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

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/9780521864701

© Cambridge University Press 2006

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2006
6th printing 2014

Printed in the United States of America by Sheridan Books, Inc.

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

ISBN 978-0-521-86470-1 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

To Sue and Joe

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

Contents

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

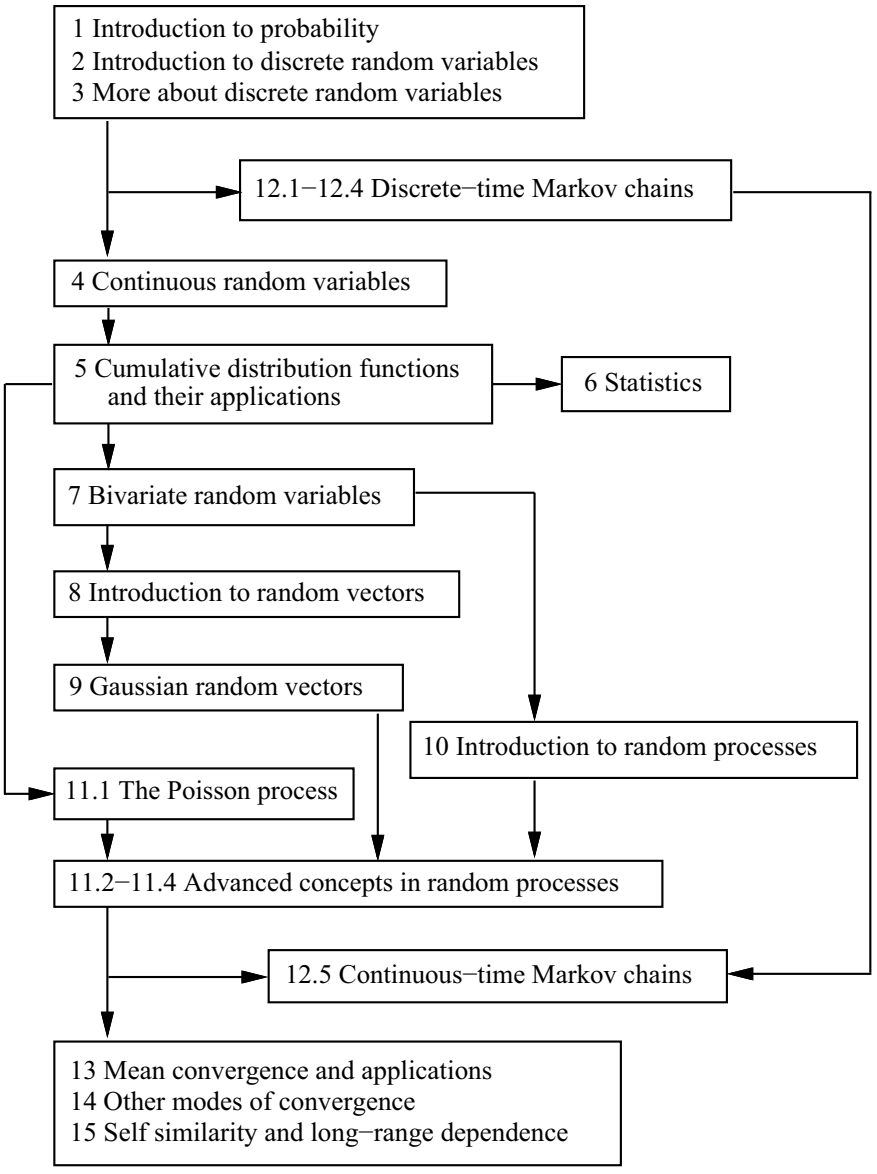
Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

Chapter dependencies



© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

Preface

Intended audience

This book is a primary text for **graduate-level courses** in probability and random processes that are typically offered in electrical and computer engineering departments. The text starts from first principles and contains more than enough material for a two-semester sequence. The **level of the text** varies from advanced undergraduate to graduate as the material progresses. The principal **prerequisite** is the usual undergraduate electrical and computer engineering course on signals and systems, e.g., Haykin and Van Veen [25] or Oppenheim and Willsky [39] (see the Bibliography at the end of the book). However, later chapters that deal with random vectors assume some familiarity with linear algebra; e.g., determinants and matrix inverses.

How to use the book

A first course. In a course that assumes at most a modest background in probability, the core of the offering would include Chapters 1–5 and 7. These cover the basics of probability and discrete and continuous random variables. As the chapter dependencies graph on the preceding page indicates, there is considerable flexibility in the selection and ordering of additional material as the instructor sees fit.

A second course. In a course that assumes a solid background in the basics of probability and discrete and continuous random variables, the material in Chapters 1–5 and 7 can be reviewed quickly. In such a review, the instructor may want include **sections and problems marked with a *, as these indicate more challenging material that might not be appropriate in a first course**. Following the review, the core of the offering would include Chapters 8, 9, 10 (Sections 10.1–10.6), and Chapter 11. Additional material from Chapters 12–15 can be included to meet course goals and objectives.

Level of course offerings. In any course offering, the level can be adapted to the background of the class by omitting or including the **more advanced sections, remarks, and problems that are marked with a ***. In addition, discussions of a highly technical nature are placed in a Notes section at the end of the chapter in which they occur. Pointers to these discussions are indicated by **boldface numerical superscripts** in the text. These notes can be omitted or included as the instructor sees fit.

Chapter features

- Key equations are boxed:

$$\boxed{\mathsf{P}(A|B) := \frac{\mathsf{P}(A \cap B)}{\mathsf{P}(B)}.}$$

- Important text passages are highlighted:

  Two events A and B are said to be independent if $\mathsf{P}(A \cap B) = \mathsf{P}(A)\,\mathsf{P}(B)$.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-86470-1 - Probability and Random Processes for Electrical and Computer Engineers
John A. Gubner
Frontmatter
More information

- Tables of discrete random variables and of Fourier transform pairs are found inside the front cover. A table of continuous random variables is found inside the back cover.
- The index was compiled as the book was written. Hence, there are many cross-references to related information. For example, see "chi-squared random variable."
- When cumulative distribution functions or other functions are encountered that do not have a closed form, MATLAB commands are given for computing them; see "Matlab commands" in the index for a list. The use of many commands is illustrated in the examples and the problems throughout most of the text. Although some commands require the MATLAB Statistics Toolbox, alternative methods are also suggested; e.g., the use of `erf` and `erfinv` for `normcdf` and `norminv`.
- Each chapter contains a **Notes** section. Throughout each chapter, numerical superscripts refer to discussions in the Notes section. These notes are usually rather technical and address subtleties of the theory.
- Each chapter contains a **Problems** section. There are more than 800 problems throughout the book. Problems are grouped according to the section they are based on, and this is clearly indicated. This enables the student to refer to the appropriate part of the text for background relating to particular problems, and it enables the instructor to make up assignments more quickly. In chapters intended for a first course, **the more challenging problems are marked with a** $\star$. Problems requiring MATLAB are indicated by the label **MATLAB.**
- Each chapter contains an **Exam preparation** section. This serves as a chapter summary, drawing attention to key concepts and formulas.

Acknowledgements

The writing of this book has been greatly improved by the suggestions of many people.

At the University of Wisconsin–Madison, the sharp eyes of the students in my classes on probability and random processes, my research students, and my postdocs have helped me fix countless typos and improve explanations of several topics. My colleagues here have been generous with their comments and suggestions. Professor Rajeev Agrawal, now with Motorola, convinced me to treat discrete random variables before continuous random variables. Discussions with Professor Bob Barmish on robustness of rational transfer functions led to Problems 38–40 in Chapter 5. I am especially grateful to Professors Jim Bucklew, Yu Hen Hu, and Akbar Sayeed, who taught from early, unpolished versions of the manuscript.

Colleagues at other universities and students in their classes have also been generous with their support. I thank Professors Toby Berger, Edwin Chong, and Dave Neuhoff, who have used recent manuscripts in teaching classes on probability and random processes and have provided me with detailed reviews. Special thanks go to Professor Tom Denney for his multiple careful reviews of each chapter.

Since writing is a solitary process, I am grateful to be surrounded by many supportive family members. I especially thank my wife and son for their endless patience and faith in me and this book, and I thank my parents for their encouragement and help when I was preoccupied with writing.

© in this web service Cambridge University Press www.cambridge.org