Oeabt 基座光学
Optics Experiment and Basic Teaching
Oeabt Optics Technology

激光篇 基座光学专业文集

(内容来自网络,由基座光学搜集整理,仅供学习交流使用)

激光电子学

Electronics Optoelectronics J T Verdeyer Laser Electronics

Laser Electronics

THIRD EDITION

JOSEPH T. VERDEYEN

Department of Electrical and Computer Engineering
University of Illinois at Urbana-Champaign, Urbana, Illinois

PRENTICE HALL SERIES IN SOLID STATE PHYSICAL ELECTRONICS
Nick Holonyak, Jr., Series Editor

PRENTICE HALL
Englewood Cliffs, New Jersey 07632

版权免责声明

本文集内容均来源于网络，版权归著作方所有。广州基座光学科技有限公司仅做搜集整理工作，并供读者学习参考用途。在使用本文集内容时可能造成实际或预期的损失，读者转载时破坏电子文档的完整性，或以商业盈利目的复制和销售等行为，本公司概不承担任何责任。若原文版权方有异议，请联系我们删除。

Library of Congress Cataloging-in-Publication Data

Verdeyen, Joseph Thomas
Laser electronics / Joseph T. Verdeyen. — 3rd ed.
p. cm. — (Prentice Hall series in solid state physical electronics)
Includes bibliographical references and index.
ISBN 0-13-706666-X
1. Lasers. 2. Semiconductor lasers. I. Title. II. Series.
TA1675.V47 1995
621.36'61—dc20 93-2184
CIP

Acquisitions editor: ***Alan Apt***
Production editor: ***Irwin Zucker***
Copy editor: ***Michael Schwartz***
Production coordinator: ***Linda Behrens***
Supplements editor: ***Alice Dworkin***
Cover design: ***Design Solutions***
Cover illustration: ***Dr. R. F. Bryan of Photonics Research***
Editorial assistant: ***Shirley McGuire***

Printed in the United States of America

10 9 8 7 6 5 4 3 2

ISBN 0-13-706666-X

Prentice-Hall International (UK) Limited, *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall Hispanoamericana, S.A., *Mexico*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Simon & Schuster Asia Pte. Ltd., *Singapore*
Editora Prentice Hall do Brasil, Ltda., *Rio de Janeiro*

This book is dedicated to Katie,
my wife, constant companion, and best friend
for 40 years of marriage and courtship.
She is the loving mother of my children Mary, Joe, Jean, and Mike,
an exciting grandmother to their children,
and an understanding mother-in-law to Dennis, Pam, Jim, and Tammy.
She has demonstrated incredible patience and understanding
with the rather painful process of revising this book while maintaining
a most pleasant, cheerful and comforting home.
From my perspective, our marriage has had a storybook characteristic to it
with my love for her increasing daily.
With her enthusiasm, example, and love, it is easy to learn
to love God, to love our neighbors, and to keep His commandments.
Thank you honey for my life!

Preface

The underlying philosophy of this third edition of *Laser Electronics* is the same as in the previous two: lasers are very simple devices and are far simpler than the very complicated high frequency RF or microwave transistor circuits. The main purpose of the book is to convince the student of this fact. In one sense, lasers are a simple movement of the decimal point on the frequency scale three to five places to the right, but much of the terminology and all of the insight developed by the earlier pioneers of radio have been translated to the optical domain.

The potential of the many applications of lasers and optical phenomena has necessitated the formation of a new word to describe the field: *photonics*. One would be hard pressed to define all of its ramifications since new ideas, devices, and applications are frequently being added. In a very loose sort of way, the early history of radio is being repeated in the optical frequency domain, and this is a theme that will be employed throughout the book. Although both have a common basis in electromagnetic theory, there are special phenomena peculiar to the optical wavelengths.

For instance, a wave intensity of 10^{15}–10^{19} watts/m^2 would have been incomprehensible in 1960, but is now attainable with rather common lasers and comparatively cheap optics. Similarly, a 50 femtoseconds (50×10^{-15} s) pulse requires more frequency bandwidth for transmission than that which was installed in all of the telecommunications networks of 1960. Yet such a pulse is rather common with optical techniques.

The ability to generate such short pulses and transmit them over significant distances (many hundreds of kilometers) by using low loss fibers and erbium-doped fiber amplifiers (EDFA) was a major impetus for the revisions incorporated into this third edition.

Chapter 4 has been changed to emphasize some of the more sophisticated aspects of guided wave propagation. such as dispersion in fibers. solitons, and perturbation theory. By necessity. the chapter is an introduction intended to encourage further investigation. While those are important topics for a communication system. they may be too involved for a first course in lasers. Thus, the entire chapter can be skipped if the focus of the course is on the *generation* portion of photonics.

Chapter 9 has been rewritten and reorganized to emphasize the dynamics of the laser: the approach to CW oscillation, Q switching, and various aspects of mode locking. The latter has been greatly expanded. but, even so, there are important topics not included.

Various additions have been included in Chapter 10 on specific laser systems. The example of a semiconductor laser pumping a YAG system was carried through in some detail so as to emphasize the application of the theoretical tools developed in the previous chapters and to indicate a significant application of the semiconductor laser. The *erbium doped fiber amplifier* (EDFA) is also discussed here, and a fairly long-winded simplified "problem" (with answers) is given to emphasize some of the unique considerations of the topic and to encourage further investigation of the literature. The multiplicity of levels of the EDFA serves as an introduction to gain/absorption between bands and to tunable vibronic lasers such as alexandrite. Ti:sapphire, and dye lasers.

Much of the expansion in photonics is being led by the improvements in the semiconductor laser, which has become the dominant laser for communication and control. Its use as a pump for the fiber amplifiers and solid-state lasers has also become most important. Chapter 11 has been expanded somewhat but is still intended to be an introduction to a course devoted entirely to that laser.

Most students have a fair grasp of the beauty and elegance of electromagnetic theory but have the mistaken view that the word *photon* somehow weakens its applicability. That is unfortunate. The lowest power laser generates literally billions of photons per second. and thus the classical field description of it is quite adequate. Even when the photon flux becomes small—say 10 to 100 s^{-1}, the classical field description will handle the practical cases. Many of the advances in semiconductor lasers. in particular, can be traced to classical electromagnetic theory of guidance of the modes by the heterostructures. Chapter 12 is included to introduce the student to some of the more advanced topics. possibly to be studied in a second course.

Chapters 13 and 14 are aimed at the student who wants a gradual transition to a quantum theory of the laser while the simple theory is fresh. Chapter 14 is an attempt to provide a bridge between the simple rate equation description of a laser and the more formal quantum theory using the density matrix. The two approaches agree. precisely. for the case of a CW two-level system. but the former is much easier and more akin to the student's background. The latter will handle the transient cases, scattering, two-photon phenomena. etc., at the expense of considerably more mathematics. The serious student should become aware of the transition between the two approaches. have confidence in both, and be aware of the pitfalls and limitations, again in a second course. One of the main conclusions is that a simple rate equation of laser phenomena is quite adequate and accurate most of the time. A few cases that do not follow this rule are included.

Many more problems are included in this third edition with the primary purpose of convincing the student of the transparent simplicity of the rate equation approach. Rate equations are no more difficult than coupled circuit equations (or the differential equation describing the student's finances): There is always a source (a salary) and a loss (expenses) that may or may not be in steady state equilibrium.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge my present and former colleagues at the University of Illinois for their help, encouragement, and many discussions of the topics included here. I am particularly grateful to: N. Holonyak, Jr., for his ability and patience in communicating his masterful insight into semiconductor electronics; to J.J. Coleman for the initial encouragement to write the book and general discussions on semiconductor materials; to T.A. DeTemple, who has been most patient and helpful with my attempt to simplify some of the topics included here; to S. Bishop for his leadership as the Director of the Microelectronics Laboratory; and to P.D. Coleman who had a significant impact on my view of electrodynamics.

I would also like to thank the reviewers: Jorge Rocca of Colorado State University, Daniel Elliott of Purdue University, Raymond Rostuk of the University of Arizona, and Sally Stevens-Tammens of the University of Illinois at Urbana-Champaign.

I especially wish to thank the many students who have helped "write" and modify this book while keeping their good humor. Their enthusiasm for photonics has really been an inspiration to me. I hope that I have taught them as well as they have educated me. I am also grateful to Ms. Galena Smirnov who patiently checked much of the new material.

I am particularly grateful to Dr. Robert Bryan of Photonics Research, Inc. for his permission to use some of the figures on the cover.

Joseph T. Verdeyen

Contents

文档篇幅过长，请跳转百度云盘下载：
链接：https://pan.baidu.com/s/1mlUQWgQfdYU_9A5fCfr5Ug
提取码：nhj8