Table of Contents

- Introduction to Semiconductor Lasers
- Brief History
- Principle of Lasers
- Special Features
- Semiconductor Laser
- Materials for Semiconductor Lasers
- Introduction
- Band Structure
- Carrier Concentration
- Intrinsic and Extrinsic Semiconductor
- Applications
- E-k Diagram and Effective Mass
- Basic Theory
- Density of States
- Excess Carriers
- Diffusion and Recombination: The Continuity Equation
- I-V and Capacitance-Voltage Characteristics of p-n Junction
- Heterojunctions and Quantum Structures
- Introduction
- Alloys
- Transport of Charge Carriers
- Basic p-n Junction Theory
- Heterojunctions
- Quantum Structures
- Quantum Wells
- Quantum Wires and Quantum Dots
- Strained Layers
- Band Structures
- Introduction
- Band Theory: Bloch Functions
- The k.p Perturbation Theory Neglecting Spin
- Spin-Orbit Interaction
- Strain-Induced Band Structure
- Quantum Wells
- Waveguides and Resonators
- Introduction
- Ray Optic Theory
- Reflection Coefficients
- Modes of a Planar Waveguide
- Wave Theory of Light Guides
- 3-D Optical Waveguides
- Resonators
- Optical Processes
- Introduction

- Optical Constants
- Absorption Processes in Semiconductors
- Fundamental Absorption in Direct Gap
- Intervalence Band Absorption (IVBA)
- Free-Carrier Absorption
- Recombination and Luminescence
- Nonradiative Recombination
- Carrier Effect on Absorption and Refractive Index
- Models for DH Lasers
- Introduction
- Gain in DH Lasers
- Threshold Current
- Effect of Electric Field in Cladding on Leakage Current
- Rate Equation Model
- Rate Equations: Solution of Time-Dependent Problems
- Modulation Response
- Temperature Dependence of Threshold Current
- Quantum Well Lasers
- Excitons
- Gain Saturation
- Introduction
- Structures
- Interband Transitions
- Model Gain Calculation: Analytical Model
- Recombination in QWs
- Loss Processes in QW Lasers
- MQW Laser
- Modulation Response of QW Lasers
- Strained QW Lasers
- Type II Quantum Well Lasers
- Tunnel-Injection QW Laser
- Quantum Dots
- Introduction
- QD Growth Mechanisms and Structures
- Introductory Model for QD Lasers
- Deviation from Simple Theory: Effect of Broadening
- Subband Structures for Pyramidal QDs
- Refined Theory for Gain and Threshold
- Modulation Bandwidth: Rate Equation Analysis
- Tunnel-Injection QD Lasers
- Quantum Cascade Lasers
- Introduction
- A Brief History
- Basic Principle
- Improved Design of Structures
- Nonradiative Inter- and Intrasubband Transitions

- Some Design Issues
- Frequency Response
- Terahertz QCL
- QD QCL
- Vertical-Cavity Surface-Emitting Laser
- Structures and Basic Properties
- Elementary Theory of VCSEL
- Requirements for Components
- Characteristics of VCSELs
- Modulation Bandwidth
- Temperature Dependence
- QD-VCSEL
- Microcavity Effects and Nanolasers
- Introduction
- Tunnel Junction
- Single-Mode and Tunable Lasers
- Introduction
- Need for Single-Mode Laser
- Limitation of FP Laser
- Distributed Feedback
- DBR Laser
- DFB Laser
- Tunable Lasers
- Characteristics of Tunable Lasers
- Methods and Structures for Continuous and Discontinuous Tuning
- Tunable Vertical-Cavity Surface-Emitting Laser
- Nitride Lasers
- Introduction
- Polar Materials and Polarization Charge
- Quantum-Confined Stark Effect
- Early Work and Challenges
- Some Useful Properties of Nitrides
- First Laser Diode
- Violet c-Plane Laser
- Blue and Green Lasers
- Nonpolar and Semipolar Growth Planes
- Group IV Lasers
- Introduction
- Need for Si (Group IV) Lasers
- Problems Related to Group IV Semiconductors: Indirect Gap
- Recent Challenges
- Use of Heterostructure for Direct Bandgap Type I Structure
- Ge Laser at 1550 nm
- Mid-Infrared Laser Based on GeSn
- Incorporation of C
- Transistor Lasers

- Introduction
- Structure and Basic Working Principle
- Principle of Operation: Model Description
- Gain Compression
- Frequency Response
- Appendix I
- Appendix II
- Problems, a Reading List, and References appear at the end of each chapter