

Fundamentals Of Gas Dynamics Zucker Solution Manual

Principles of Nuclear Rocket Propulsion provides an understanding of the physical principles underlying the design and operation of nuclear fission-based rocket engines. While there are numerous texts available describing rocket engine theory and nuclear reactor theory, this is the first book available describing the integration of the two subject areas. Most of the book's emphasis is primarily on nuclear thermal rocket engines, wherein the energy of a nuclear reactor is used to heat a propellant to high temperatures and then expel it through a nozzle to produce thrust. Other concepts are also touched upon such as a section devoted to the nuclear pulse rocket concept wherein the force of externally detonated nuclear explosions is used to accelerate a spacecraft. Future crewed space missions beyond low earth orbit will almost certainly require propulsion systems with performance levels exceeding that of today's best chemical engines. A likely candidate for that propulsion system is the solid core Nuclear Thermal Rocket or NTR. Solid core NTR engines are expected to have performance levels which significantly exceed that achievable by any currently conceivable chemical engine. The challenge is in the engineering details of the design which includes not only the thermal, fluid, and mechanical aspects always present in chemical rocket engine development, but also nuclear interactions and some unique materials restrictions. Sorts and organizes information on various types of nuclear thermal rocket engines into a coherent curriculum Includes a number of example problems to illustrate the concepts being presented Features a companion site with interactive calculators demonstrating how variations in the constituent parameters affect the physical process being described Includes 3D figures that may be scaled and rotated to better visualize the nature of the object under study

In this Special Issue on human health engineering, we invited submissions exploring recent contributions to the field of human health engineering, which is the technology used for monitoring the physical or mental health status of individuals in a variety of applications. Contributions focused on sensors, wearable hardware, algorithms, or integrated monitoring systems. We organized the different papers according to their contributions to the main aspects of the monitoring and control engineering scheme applied to human health applications, including papers focusing on measuring/sensing physiological variables, contributions describing research on the modelling of biological signals, papers highlighting health monitoring applications, and finally examples of control applications for human health. In comparison to biomedical engineering, the field of human health engineering also covers applications on healthy humans (e.g., sports, sleep, and stress) and thus not only contributes to develop technology for curing patients or supporting chronically ill people, but also more generally for disease prevention and optimizing human well-being. The prerequisite for the study of this book is a knowledge of matrices and the essentials of functions of a complex variable. It has been developed from courses given by the authors and probably contains more material than will ordinarily be covered in a one-year course. It is hoped that the book will be a useful text in the application of differential equations as well as for the pure mathematician.

This book highlights recent findings in industrial, manufacturing and mechanical engineering, and provides an overview of the state

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of the art in these fields, mainly in Russia and Eastern Europe. A broad range of topics and issues in modern engineering are discussed, including the dynamics of machines and working processes, friction, wear and lubrication in machines, surface transport and technological machines, manufacturing engineering of industrial facilities, materials engineering, metallurgy, control systems and their industrial applications, industrial mechatronics, automation and robotics. The book gathers selected papers presented at the 5th International Conference on Industrial Engineering (ICIE), held in Sochi, Russia in March 2019. The authors are experts in various fields of engineering, and all papers have been carefully reviewed. Given its scope, the book will be of interest to a wide readership, including mechanical and production engineers, lecturers in engineering disciplines, and engineering graduates.

* Properties of the atmosphere are given * Tables for isothermal flow and oblique shock are included * Pressure drop in gas pipe lines is also tabulated * Gives pumping power for fans, blowers and compressors * These gas tables can be used in Mechanical Engineering, Aerospace Engineering, Chemical Engineering and Gas Engineering
Fundamentals of Gas Dynamics John Wiley & Sons

This book is rather unique in its approach and coverage. The approach is essentially that of an engineering textbook, emphasizing the quantitative aspects and highlighting the fundamentals and basic concepts involved. The coverage progresses in a logical and systematic manner from the subcellular, starting with the electrophysiology of the cell membrane, then proceeding to synapses, neurons, and muscle, before considering neuronal motor ensembles and the neuromuscular system as a whole. Simple, clear, and comprehensive explanations are given throughout. After an introductory chapter on some background material in biology, biophysics, and chemical kinetics, a substantial part of the book (Chapters 2-8) necessarily covers in considerable detail the basic components and processes that underlie the electrical and associated activities of the nervous system. The remaining chapters of the book (Chapters 9-13) focus on the neuromuscular system, starting with the structure of muscle cells, the generation of force by muscular contraction, and muscle receptors. The last chapter examines aspects of the control of movement, motor learning and memory, the maintenance of posture, and locomotion, and critically examines some of the theories that have been advanced to explain how movement is controlled. The book is intended for undergraduate or graduate students in the natural sciences, mathematics, or engineering who seek a deeper understanding of the fundamentals of neuroscience and the somatomotor system, in accordance with the aforementioned objectives. The book can serve as a textbook for a one-semester course on the neuromuscular system or as a reference in a more general course on neuroscience. Provides a thorough analytical treatment of membrane electrophysiology, starting from the first principles Emphasizes strongly the basic and fundamental concepts throughout Discusses thoroughly the essential features and properties of the basic constituents of the nervous system, that is, neurons and synapses, including the neuromuscular junction Explains the main aspects of posture, locomotion, and control of movement Includes practice problems throughout the text and a solutions manual will be available for adopting professors Nassir Sabah is professor of biomedical engineering in the electrical and computer engineering department at the American University of

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Beirut, Lebanon. He received his B.Sc. (Hons. Class I) and his M.Sc. in electrical engineering from the University of Birmingham, U.K., and his Ph.D. in biophysical sciences from the State University of New York (SUNY/Buffalo). He has served as Chairman of the Electrical Engineering Department, Director of the Institute of Computer Studies, and Dean of the Faculty of Engineering and Architecture at the American University of Beirut. In these capacities, he was responsible for the development of programs, curricula, and courses in electrical, biomedical, communications, and computer engineering. Professor Sabah has extensive professional experience in the fields of electrical engineering, electronics, and computer systems, with more than 35 years' teaching experience in neuroengineering, biomedical engineering, electronics, and electric circuits. He has over 100 technical publications, mainly in neurophysiology, biophysics, and biomedical instrumentation. He has served on numerous committees and panels in Lebanon and the region. He is a Fellow of the Institution of Engineering and Technology (IET, U.K.), a member of the American Association for the Advancement of Science (AAAS), and a member of the American Society for Engineering Education (ASEE).

Based on a well tried-and-tested lecture at the Russian State University of Oil and Gas, this accessible approach to the theory of pipeline transportation provides systematic coverage of various kinds of fluids, backed by real-world examples. From the contents: * Fundamentals of mathematical modeling of one-dimensional flows * Models of transported media * Structure of laminar and turbulent fluid flows * Modeling and calculation of steady-state regimes * Closed mathematical models of one-dimensional fluid and gas flows * Dimensional theory * Physical modeling of phenomena * Dimension and similarity in mathematical modeling of processes End-of-chapter problems make this practical book consistent and suitable for self-study.

This introductory 2005 text on air-breathing jet propulsion focuses on the basic operating principles of jet engines and gas turbines. Previous coursework in fluid mechanics and thermodynamics is elucidated and applied to help the student understand and predict the characteristics of engine components and various types of engines and power gas turbines. Numerous examples help the reader appreciate the methods and differing, representative physical parameters. A capstone chapter integrates the text material into a portion of the book devoted to system matching and analysis so that engine performance can be predicted for both on- and off-design conditions. The book is designed for advanced undergraduate and first-year graduate students in aerospace and mechanical engineering. A basic understanding of fluid dynamics and thermodynamics is presumed. Although aircraft propulsion is the focus, the material can also be used to study ground- and marine-based gas turbines and turbomachinery and some advanced topics in compressors and turbines.

Membranes play an enormous role in our life. Biological cell membranes control the fluxes of substances in and out of

cells. Artificial membranes are widely used in numerous applications including “green” separation processes in chemistry, agroindustry, biology, medicine; they are used as well in energy generation from renewable sources. They largely mimic the structure and functions of biological membranes. The similarity in the structure leads to the similarity in the properties and the approaches to study the laws governing the behavior of both biological and artificial membranes. In this book, some physico-chemical and chemico-physical aspects of the structure and behavior of biological and artificial membranes are investigated.

Provides undergraduates and practicing engineers with an understanding of the theory and applications behind the fundamental concepts of machine elements. This text includes examples and homework problems designed to test student understanding and build their skills in analysis and design.

Proceedings of a NATO ARW held in Vimeiro, Portugal, May 11-15, 1992

Publisher Description

Written by one of the most successful aerospace authors, this new book develops aircraft performance techniques from first principles and applies them to real airplanes. It also addresses a philosophy of, and techniques for aircraft design. By developing and discussing these two subjects in a single text, the author captures a degree of synergism not found in other texts. The book is written in a conversational style, a trademark of all of John Anderson's texts, to enhance the readers' understanding.

Appropriate for upper-division undergraduate and graduate level courses in computer vision found in departments of computer science, computer engineering and electrical engineering, this book offers a treatment of modern computer vision methods.

This book provides a comprehensive basics-to-advanced course in an aero-thermal science vital to the design of engines for either type of craft. The text classifies engines powering aircraft and single/multi-stage rockets, and derives performance parameters for both from basic aerodynamics and thermodynamics laws. Each type of engine is analyzed for optimum performance goals, and mission-appropriate engines selection is explained. Fundamentals of Aircraft and Rocket Propulsion provides information about and analyses of: thermodynamic cycles of shaft engines (piston, turboprop, turboshaft and propfan); jet engines (pulsejet, pulse detonation engine, ramjet, scramjet, turbojet and turbofan); chemical and non-chemical rocket engines; conceptual design of modular rocket engines (combustor, nozzle and turbopumps); and conceptual design of different modules of aero-engines in their design and off-design state. Aimed at graduate and final-year undergraduate students, this textbook provides a thorough grounding in the history and classification of both aircraft and rocket engines, important design features of all the engines detailed, and particular consideration of special

aircraft such as unmanned aerial and short/vertical takeoff and landing aircraft. End-of-chapter exercises make this a valuable student resource, and the provision of a downloadable solutions manual will be of further benefit for course instructors.

Arming readers with both theoretical and practical knowledge, *Advanced Linear Algebra for Engineers with MATLAB®* provides real-life problems that readers can use to model and solve engineering and scientific problems in fields ranging from signal processing and communications to electromagnetics and social and health sciences. Facilitating a unique understanding of rapidly evolving linear algebra and matrix methods, this book: Outlines the basic concepts and definitions behind matrices, matrix algebra, elementary matrix operations, and matrix partitions, describing their potential use in signal and image processing applications Introduces concepts of determinants, inverses, and their use in solving linear equations that result from electrical and mechanical-type systems Presents special matrices, linear vector spaces, and fundamental principles of orthogonality, using an appropriate blend of abstract and concrete examples and then discussing associated applications to enhance readers' visualization of presented concepts Discusses linear operators, eigenvalues, and eigenvectors, and explores their use in matrix diagonalization and singular value decomposition Extends presented concepts to define matrix polynomials and compute functions using several well-known methods, such as Sylvester's expansion and Cayley-Hamilton Introduces state space analysis and modeling techniques for discrete and continuous linear systems, and explores applications in control and electromechanical systems, to provide a complete solution for the state space equation Shows readers how to solve engineering problems using least square, weighted least square, and total least square techniques Offers a rich selection of exercises and MATLAB® assignments that build a platform to enhance readers' understanding of the material Striking the appropriate balance between theory and real-life applications, this book provides both advanced students and professionals in the field with a valuable reference that they will continually consult.

Gas Dynamics covers all the material required for mainstream introductory courses in *Advanced Fluid Mechanics*, and *Compressible Fluid Flow*. In order to ensure complete understanding of the physical behaviour of compressible fluid flow and the principles underlying modern-day industrial experience and techniques, the authors begin with basic one-dimensional steady flow and progress to introductory two-dimensional flows and unsteady flows. Applications cover aerodynamics, turbomachinery, gas turbines and common engineering designs. Each chapter begins with basic principles, provides full derivation of results, explores the theory via worked problems and exercises (answers provided in a separate solutions manual), and has been extensively class-tested.

A revised edition to applied gas dynamics with exclusive coverage on jets and additional sets of problems and examples

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The revised and updated second edition of Applied Gas Dynamics offers an authoritative guide to the science of gas dynamics. Written by a noted expert on the topic, the text contains a comprehensive review of the topic; from a definition of the subject, to the three essential processes of this science: the isentropic process, shock and expansion process, and Fanno and Rayleigh flows. In this revised edition, there are additional worked examples that highlight many concepts, including moving shocks, and a section on critical Mach number is included that helps to illuminate the concept. The second edition also contains new exercise problems with the answers added. In addition, the information on ram jets is expanded with helpful worked examples. It explores the entire spectrum of the ram jet theory and includes a set of exercise problems to aid in the understanding of the theory presented. This important text: Includes a wealth of new solved examples that describe the features involved in the design of gas dynamic devices Contains a chapter on jets; this is the first textbook material available on high-speed jets Offers comprehensive and simultaneous coverage of both the theory and application Includes additional information designed to help with an understanding of the material covered Written for graduate students and advanced undergraduates in aerospace engineering and mechanical engineering, Applied Gas Dynamics, Second Edition expands on the original edition to include not only the basic information on the science of gas dynamics but also contains information on high-speed jets.

In 1872, Boltzmann published a paper which for the first time provided a precise mathematical basis for a discussion of the approach to equilibrium. The paper dealt with the approach to equilibrium of a dilute gas and was based on an equation - the Boltzmann equation, as we call it now - for the velocity distribution function of such a gas. The Boltzmann equation still forms the basis of the kinetic theory of gases and has proved fruitful not only for the classical gases Boltzmann had in mind, but also - if properly generalized - for the electron gas in a solid and the excitation gas in a superfluid. Therefore it was felt by many of us that the Boltzmann equation was of sufficient interest, even today, to warrant a meeting, in which a review of its present status would be undertaken. Since Boltzmann had spent a good part of his life in Vienna, this city seemed to be a natural setting for such a meeting. The first day was devoted to historical lectures, since it was generally felt that apart from their general interest, they would furnish a good introduction to the subsequent scientific sessions. We are very much indebted to Dr. D.

“Open Water is tender poetry, a love song to Black art and thought, an exploration of intimacy and vulnerability between two young artists learning to be soft with each other in a world that hardens against Black people.”—Yaa Gyasi, author of *HOME GOING* In a crowded London pub, two young people meet. Both are Black British, both won scholarships to private schools where they struggled to belong, both are now artists—he a photographer, she a dancer—and both are trying to make their mark in a world that by turns celebrates and rejects them. Tentatively, tenderly, they fall in love. But

two people who seem destined to be together can still be torn apart by fear and violence, and over the course of a year they find their relationship tested by forces beyond their control. Narrated with deep intimacy, *Open Water* is at once an achingly beautiful love story and a potent insight into race and masculinity that asks what it means to be a person in a world that sees you only as a Black body; to be vulnerable when you are only respected for strength; to find safety in love, only to lose it. With gorgeous, soulful intensity, and blistering emotional intelligence, Caleb Azumah Nelson gives a profoundly sensitive portrait of romantic love in all its feverish waves and comforting beauty. This is one of the most essential debut novels of recent years, heralding the arrival of a stellar and prodigious young talent.

This book discusses the physical properties of noble fluids, operational principles of detectors based on these media, and the best technical solutions to the design of these detectors. Essential attention is given to detector technology: purification methods and monitoring of purity, information readout methods, electronics, detection of hard ultra-violet light emission, selection of materials, cryogenics etc. The book is mostly addressed to physicists and graduate students involved in the preparation of fundamental next generation experiments, nuclear engineers developing instrumentation for national nuclear security and for monitoring nuclear materials.

Effective risk communication is essential to the well-being of any organization and those people who depend on it. Ineffective communication can cost lives, money and reputations. *Communicating Risks and Benefits: An Evidence-Based User's Guide* provides the scientific foundations for effective communications. The book authoritatively summarizes the relevant research, draws out its implications for communication design, and provides practical ways to evaluate and improve communications for any decision involving risks and benefits. Topics include the communication of quantitative information and warnings, the roles of emotion and the news media, the effects of age and literacy, and tests of how well communications meet the organization's goals. The guide will help users in any organization, with any budget, to make the science of their communications as sound as the science that they are communicating.

Now in its third edition, *Jet Propulsion* offers a self-contained introduction to the aerodynamic and thermodynamic design of modern civil and military jet engine design. Through two-engine design projects for a large passenger and a new fighter aircraft, the text explains modern engine design. Individual sections cover aircraft requirements, aerodynamics, principles of gas turbines and jet engines, elementary compressible fluid mechanics, bypass ratio selection, scaling and dimensional analysis, turbine and compressor design and characteristics, design optimization, and off-design performance. The civil aircraft, which formed the core of Part I in the previous editions, has now been in service for several years as the Airbus A380. Attention in the aircraft industry has now shifted to two-engine aircraft with a greater emphasis on reduction of fuel burn, so the model created for Part I in this edition is the new efficient aircraft, a twin aimed at high efficiency.

Edited by acclaimed science writer and physicist James Trefil, the *Encyclopedia's* 1000 entries combine in-depth coverage with a vivid graphic format to bring every facet of science, technology, and medicine into stunning focus. From absolute zero to the Mesozoic era to semiconductors to the twin paradox, Trefil and his co-authors have an uncanny ability to convey how the universe works and to show readers how to apply that knowledge to everyday problems.

How to rewire your brain to improve virtually every aspect of your life-based on the latest research in neuroscience and psychology on neuroplasticity and evidence-based practices Not long ago, it was thought that the brain you were born with was the brain you would die with,

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and that the brain cells you had at birth were the most you would ever possess. Your brain was thought to be “hardwired” to function in predetermined ways. It turns out that's not true. Your brain is not hardwired, it's "softwired" by experience. This book shows you how you can rewire parts of the brain to feel more positive about your life, remain calm during stressful times, and improve your social relationships. Written by a leader in the field of Brain-Based Therapy, it teaches you how to activate the parts of your brain that have been underactivated and calm down those areas that have been hyperactivated so that you feel positive about your life and remain calm during stressful times. You will also learn to improve your memory, boost your mood, have better relationships, and get a good night sleep. Reveals how cutting-edge developments in neuroscience, and evidence-based practices can be used to improve your everyday life Other titles by Dr. Arden include: Brain-Based Therapy-Adult, Brain-Based Therapy-Child, Improving Your Memory For Dummies and Heal Your Anxiety Workbook Dr. Arden is a leader in integrating the new developments in neuroscience with psychotherapy and Director of Training in Mental Health for Kaiser Permanente for the Northern California Region Explaining exciting new developments in neuroscience and their applications to daily living, Rewire Your Brain will guide you through the process of changing your brain so you can change your life and be free of self-imposed limitations.

This book is the result of more than ten years of research and teaching in the field of quantum electronics. The purpose of the book is to introduce the principles of lasers, starting from elementary notions of quantum mechanics and electromagnetism. Because it is an introductory book, an effort has been made to make it self contained to minimize the need for reference to other works. For the same reason; the references have been limited (whenever possible) either to review papers or to papers of seminal importance. The organization of the book is based on the fact that a laser can be thought of as consisting of three elements: (i) an active material, (ii) a pumping system, and (iii) a suitable resonator. Accordingly, after an introductory chapter, the next three chapters deal, respectively, with the interaction of radiation with matter, pumping processes, and the theory of passive optical resonators.

New edition of the popular textbook, comprehensively updated throughout and now includes a new dedicated website for gas dynamic calculations The thoroughly revised and updated third edition of Fundamentals of Gas Dynamics maintains the focus on gas flows below hypersonic. This targeted approach provides a cohesive and rigorous examination of most practical engineering problems in this gas dynamics flow regime. The conventional one-dimensional flow approach together with the role of temperature-entropy diagrams are highlighted throughout. The authors—noted experts in the field—include a modern computational aid, illustrative charts and tables, and myriad examples of varying degrees of difficulty to aid in the understanding of the material presented. The updated edition of Fundamentals of Gas Dynamics includes new sections on the shock tube, the aerospoke nozzle, and the gas dynamic laser. The book contains all equations, tables, and charts necessary to work the problems and exercises in each chapter. This book's accessible but rigorous style: Offers a comprehensively updated edition that includes new problems and examples Covers fundamentals of gas flows targeting those below hypersonic Presents the one-dimensional flow approach and highlights the role of temperature-entropy diagrams Contains new sections that examine the shock tube, the aerospoke nozzle, the gas dynamic laser, and an expanded coverage of rocket propulsion Explores applications of gas dynamics to aircraft and rocket engines Includes behavioral objectives, summaries, and check tests to aid with learning Written for students in mechanical and aerospace engineering and professionals and researchers in the field, the third edition of Fundamentals of Gas Dynamics has been updated to include recent developments in the field and retains all its learning aids. The calculator for gas dynamics calculations is available at <https://www.oscarbiblarz.com/gascalculator> gas dynamics calculations

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The book deals with the fundamentals, theoretical bases, and design methodologies of conventional internal combustion engine (ICE) vehicles, electric vehicles (EVs), hybrid electric vehicles (HEVs), and fuel cell vehicles (FCVs). The design methodology is described in mathematical terms, step-by-step, and the topics are approached from the overall drive train system, not just individual components. Furthermore, in explaining the design methodology of each drive train, design examples are presented with simulation results.

Fundamental Neuroscience, 3rd Edition introduces graduate and upper-level undergraduate students to the full range of contemporary neuroscience. Addressing instructor and student feedback on the previous edition, all of the chapters are rewritten to make this book more concise and student-friendly than ever before. Each chapter is once again heavily illustrated and provides clinical boxes describing experiments, disorders, and methodological approaches and concepts. Capturing the promise and excitement of this fast-moving field, Fundamental Neuroscience, 3rd Edition is the text that students will be able to reference throughout their neuroscience careers! New to this edition: 30% new material including new chapters on Dendritic Development and Spine Morphogenesis, Chemical Senses, Cerebellum, Eye Movements, Circadian Timing, Sleep and Dreaming, and Consciousness Additional text boxes describing key experiments, disorders, methods, and concepts Multiple model system coverage beyond rats, mice, and monkeys Extensively expanded index for easier referencing

Compressible Fluid Dynamics (or Gas Dynamics) has a wide range of applications in Mechanical, Aeronautical and Chemical Engineering. It plays a significant role in the design and development of compressors, turbines, missiles, rockets and aircrafts. This comprehensive and systematically organized book gives a clear analysis of the fundamental principles of Compressible Fluid Dynamics. It discusses in rich detail such topics as isentropic, Fanno, Rayleigh, simple and generalised one-dimensional flows. Besides, it covers topics such as conservation laws for compressible flow, normal and oblique shock waves, and measurement in compressible flow. Finally, the book concludes with detailed discussions on propulsive devices. The text is amply illustrated with worked-out examples, tables and diagrams to enable the students to comprehend the subject with ease. Intended as a text for undergraduate students of Mechanical, Aeronautical and Chemical Engineering, the book would also be extremely useful for practising engineers.

The Subject Of Compressible Flow Or Gas Dynamics Deals With The Thermo-Fluid Dynamic Problems Of Gases And Vapours. It Is Now An Important Part Of The Undergraduate And Postgraduate Curricula. Fundamentals Of Compressible Flow Covers This Subject In Fourteen Well Organised Chapters In A Lucid Style. A Large Mass Of Theoretical Material And Equations Has Been Supported By A Number Of Figures And Graphical Depictions. Author'S Sprawling Teaching Experience In This Subject And Allied Areas Is Reflected In The Clarity, And Systematic And Logical Presentation. Salient Features * Begins With Basic Definitions And Formulas. * Separate Chapters On Adiabatic Flow, Isentropic Flow And Rate Equations. * Includes Basics Of The Atmosphere, And Measuring Techniques. Separate Sections On Wind Tunnels, Laser Techniques, Hot Wires And Flow Measurement. * Discusses Applications In Aircraft And Rocket Propulsion, Space Flights, And Pumping Of Natural Gas. * Contains Large Number Of Solved And Unsolved Problems. The Present Edition Has An Additional Chapter (14) On Miscellaneous Problems In Compressible Flow (Gas Dynamics). This Is Designed To Support The Tutorials, Practice Exercises And Examinations. Problems Have Been Specially Chosen For Students And Engineers In The Areas Of Aerospace, Chemical, Gas And Mechanical Engineering.

NEW YORK TIMES BEST SELLER • A grand, devastating portrait of three generations of the Sackler family, famed for their philanthropy, whose fortune was built by Valium and whose reputation was destroyed by OxyContin. From the prize-winning and bestselling author of Say Nothing, as featured in the HBO documentary Crime of the Century. The Sackler name adorns the walls of many storied institutions—Harvard,

the Metropolitan Museum of Art, Oxford, the Louvre. They are one of the richest families in the world, known for their lavish donations to the arts and the sciences. The source of the family fortune was vague, however, until it emerged that the Sacklers were responsible for making and marketing a blockbuster painkiller that was the catalyst for the opioid crisis. *Empire of Pain* begins with the story of three doctor brothers, Raymond, Mortimer and the incalculably energetic Arthur, who weathered the poverty of the Great Depression and appalling anti-Semitism. Working at a barbaric mental institution, Arthur saw a better way and conducted groundbreaking research into drug treatments. He also had a genius for marketing, especially for pharmaceuticals, and bought a small ad firm. Arthur devised the marketing for Valium, and built the first great Sackler fortune. He purchased a drug manufacturer, Purdue Frederick, which would be run by Raymond and Mortimer. The brothers began collecting art, and wives, and grand residences in exotic locales. Their children and grandchildren grew up in luxury. Forty years later, Raymond's son Richard ran the family-owned Purdue. The template Arthur Sackler created to sell Valium—co-opting doctors, influencing the FDA, downplaying the drug's addictiveness—was employed to launch a far more potent product: OxyContin. The drug went on to generate some thirty-five billion dollars in revenue, and to launch a public health crisis in which hundreds of thousands would die. This is the saga of three generations of a single family and the mark they would leave on the world, a tale that moves from the bustling streets of early twentieth-century Brooklyn to the seaside palaces of Greenwich, Connecticut, and Cap d'Antibes to the corridors of power in Washington, D.C. *Empire of Pain* chronicles the multiple investigations of the Sacklers and their company, and the scorched-earth legal tactics that the family has used to evade accountability. The history of the Sackler dynasty is rife with drama—baroque personal lives; bitter disputes over estates; fistfights in boardrooms; glittering art collections; Machiavellian courtroom maneuvers; and the calculated use of money to burnish reputations and crush the less powerful. *Empire of Pain* is a masterpiece of narrative reporting and writing, exhaustively documented and ferociously compelling. It is a portrait of the excesses of America's second Gilded Age, a study of impunity among the super elite and a relentless investigation of the naked greed and indifference to human suffering that built one of the world's great fortunes.

The gold-standard reference on the design and application of classic and modern antennas—fully updated to reflect the latest advances and technologies This new edition of the “bible of antenna engineering” has been updated to provide start-to-finish coverage of the latest innovations in antenna design and application. You will find in-depth discussion of antennas used in modern communication systems, mobile and personal wireless technologies, satellites, radar deployments, flexible electronics, and other emerging technologies, including 5G, terahertz, and wearable electronics. *Antenna Engineering Handbook, Fifth Edition*, is bolstered by real-world examples, hundreds of illustrations, and an emphasis on the practical aspects of antennas. Featuring 60 chapters and contributions from more than 80 renowned experts, this acclaimed resource is edited by one of the world's leading antenna authorities. This edition features all of the classic antenna types, plus new and emerging designs, with 13 all-new chapters and important updates to nearly all chapters from past editions. *Antenna Engineering Handbook, Fifth Edition*, clearly explains cutting-edge applications in WLANs, automotive systems, PDAs, and handheld devices, making it an indispensable companion for today's antenna practitioners and developers. Coverage includes:

- Antenna basics and classic antennas
- Design approaches for antennas and arrays
- Wideband and multiband antennas
- Antennas for mobile devices and PDAs, automotive applications, and aircraft
- Base station and smart antennas
- Beamforming and 5G antennas
- Millimeter-wave and terahertz antennas
- Flexible, wearable, thin film, origami, dielectric, and on-chip antennas
- MIMO antennas and phased arrays
- Direction-finding and GPS antennas
- Active antennas
- Low-profile wideband antennas
- Nanoantennas
- Reflectors and other satellite and radio-telescope antennas
- Low-frequency, HF, VHF, UHF, ECM, and ESM antennas
- Impedance-matching techniques and material

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characteristics•Metastructured and frequency selective surfaces•Propagation and guided structures•Computational techniques and toolsets•Indoor and outdoor measurements

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