

Course In Mathematical Physics

In the past decade the language and methods of modern differential geometry have been increasingly used in theoretical physics. What seemed extravagant when this book first appeared 12 years ago, as lecture notes, is now a commonplace. This fact has strengthened my belief that today students of theoretical physics have to learn that language-and the sooner the better. Afterall, they will be the professors of the twenty-first century and it would be absurd if they were to teach then the mathematics of the nineteenth century. Thus for this new edition I did not change the mathematical language. Apart from correcting some mistakes I have only added a section on gauge theories. In the last decade it has become evident that these theories describe fundamental interactions, and on the classical level their structure is sufficiently clear to qualify them for the minimum amount of knowledge required by a theoretician. It is with much regret that I had to refrain from incorporating the interesting developments in Kaluza-Klein theories and in cosmology, but I felt bound to my promise not to burden the students with theoretical speculations for which there is no experimental evidence. I am indebted to many people for suggestions concerning this volume. In particular, P. Aichelburg, H. Rumpf and H. Urbantke have contributed generously to corrections and improvements. Finally, I would like to thank Dr. 1. Dahl-Jensen for redoing some of the figures on the computer.

This textbook presents mathematical physics in its chronological order. It originated in a four-semester course I offered to both mathematicians and physicists, who were only required to have taken the conventional introductory courses. In order to be able to cover a suitable amount of advanced material for graduate students, it was necessary to make a careful selection of topics. I decided to cover only those subjects in which one can work from the basic laws to derive physically relevant results with full mathematical rigor. Models which are not based on realistic physical laws can at most serve as illustrations of mathematical theorems, and theories whose predictions are only related to the basic principles through some uncontrollable approximation have been omitted. The complete course comprises the following one-semester lecture series: I. Classical Dynamical Systems II. Classical Field Theory III. Quantum Mechanics of Atoms and Molecules IV. Quantum Mechanics of Large Systems Unfortunately, some important branches of physics, such as the relativistic quantum theory, have not yet matured from the stage of rules for calculations to mathematically well understood disciplines, and are therefore not taken up. The above selection does not imply any value judgment, but only attempts to be logically and didactically consistent. General mathematical knowledge is assumed, at the level of a beginning graduate student or advanced undergraduate majoring in physics or mathematics.

Mathematical Physics with Partial Differential Equations, Second Edition, is designed for upper division undergraduate and beginning graduate students taking mathematical physics taught out by math departments. The new edition is based on the success of the first, with a continuing focus on clear presentation, detailed examples, mathematical rigor and a careful selection of topics. It presents the familiar classical topics and methods of mathematical physics with more extensive coverage of the three most important partial differential equations in the field of mathematical physics—the heat equation, the wave equation and Laplace’s equation. The book presents the most common techniques of solving these equations, and their derivations are developed in detail for a deeper understanding of mathematical applications. Unlike many physics-leaning mathematical physics books on the market, this work is heavily rooted in math, making the book more appealing for students wanting to progress in mathematical physics, with particularly deep coverage of Green’s functions, the Fourier transform, and the Laplace transform. A salient characteristic is the focus on fewer topics but at a far more rigorous level of detail than comparable undergraduate-facing textbooks. The depth of some of these topics, such as the Dirac-delta distribution, is not matched elsewhere. New features in this edition include: novel and illustrative examples from physics including the 1-dimensional quantum mechanical oscillator, the hydrogen atom and the rigid rotor model; chapter-length discussion of relevant functions, including the Hermite polynomials, Legendre polynomials, Laguerre polynomials and Bessel functions; and all-new focus on complex examples only solvable by multiple methods. Introduces and evaluates numerous physical and engineering concepts in a rigorous mathematical framework Provides extremely detailed mathematical derivations and solutions with extensive proofs and weighting for application potential Explores an array of detailed examples from physics that give direct application to rigorous mathematics Offers instructors useful resources for teaching, including an illustrated instructor’s manual, PowerPoint presentations in each chapter and a solutions manual

Many physical processes in fields such as mechanics, thermodynamics, electricity, magnetism or optics are described by means of partial differential equations. The aim of the present book is to demonstrate the basic methods for solving the classical linear problems in mathematical physics of elliptic, parabolic and hyperbolic type. In particular, the methods of conformal mappings, Fourier analysis and Green’s functions are considered, as well as the perturbation method and integral transformation method, among others. Every chapter contains concrete examples with a detailed analysis of their solution. The book is intended as a textbook for students in mathematical physics, but will also serve as a handbook for scientists and engineers.

A Modern Introduction to Its Foundations

International Series of Monographs in Pure and Applied Mathematics

Applied Mathematics for Scientists and Engineers

A Course in Mathematical Physics 1 and 2

A First Course in Mathematical Physics

Publisher Description

Graduate-level text offers unified treatment of mathematics applicable to many branches of physics. Theory of vector spaces, analytic function theory, theory of integral equations, group theory, and more. Many problems. Bibliography.

A comprehensive survey of all the mathematical methods that should be available to graduate students in physics. In addition to the usual topics of analysis, such as infinite series, functions of a complex variable and some differential equations as well as linear vector spaces, this book includes a more extensive discussion of group theory than can be found in other current textbooks. The main feature of this textbook is its extensive treatment of geometrical methods as applied to physics. With its introduction of differentiable manifolds and a discussion of vectors and forms on such manifolds as part of a first-year graduate course in mathematical methods, the text allows students to grasp at an early stage the contemporary literature on dynamical systems, solitons and related topological solutions to field equations, gauge theories, gravitational theory, and even string theory. Free solutions manual available for lecturers at www.wiley-vch.de/supplements/.

A textbook covering the theory and physical applications of linear algebra and the calculus of several variables.

A Course in Mathematical Physics 2

A Course in Mathematical Physics

Classical dynamical systems. 1

From Classical Mechanics to Advanced Quantum Statistics

Mathematical Methods for Physics and Engineering

Suitable for advanced undergraduate and graduate students, this new textbook contains an introduction to the mathematical concepts used in physics and engineering. The entire book is unique in that it draws upon applications from physics, rather than mathematical examples, to ensure students are fully equipped with the tools they need. This approach prepares the reader for advanced topics, such as quantum mechanics and general relativity, while offering examples, problems, and insights into classical physics. The book is also distinctive in the coverage it devotes to modelling, and to often-neglected topics such as Green’s functions.

This textbook is aimed at advanced undergraduate and graduate students interested in learning the fundamental mathematical concepts and tools widely used in different areas of physics. The author draws on a vast teaching experience, and presents a comprehensive and self-contained text which explains how mathematics intertwines with and forms an integral part of physics in numerous instances. Rather than emphasizing rigorous proofs of theorems, specific examples and physical applications (such as fluid dynamics, electromagnetism, quantum mechanics, etc.) are invoked to illustrate and elaborate upon the relevant mathematical techniques. The early chapters of the book introduce different types of functions, vectors and tensors, vector calculus, and matrices. In the subsequent chapters, more advanced topics like linear spaces, operator algebras, special functions, probability distributions, stochastic processes, analytic functions, Fourier series and integrals, Laplace transforms, Green’s functions and integral equations are discussed. The book also features about 400 exercises and solved problems interspersed throughout the text at appropriate junctures, to facilitate the logical flow and to test the key concepts. Overall this book will be a valuable resource for a wide spectrum of students and instructors of mathematical physics.

When a student begins with the course of Class XI he/she is bound to encounter difficulty at initial level of study due to huge gap in the syllabus of secondary and higher secondary stage. This book will serve as a Bridge course for all students moving from class X to class XI, who will take the course of Physics. This book can act as a Prerequisite for learning Physics in class XI and XII. Since this book has been aimed at the students to cover the essential mathematics Calculus & Vectors in quick time, the number of problems and questions has been restricted. Stress has been given to develop the fine link or connection between mathematics and physics and application of mathematical ideas in understanding Physics. This book will also be useful for those students who are preparing for NEET or similar Biological examinations but do not have mathematics at 10+2, but have Physics in their course of study.

This state of the art book takes an applications based approach to teaching mathematics to engineering and applied sciences students. The book lays emphasis on associating mathematical concepts with their physical counterparts, training students of engineering in mathematics to help them learn how things work. The book covers the concepts of number systems, algebra equations and calculus through discussions on mathematics and physics, discussing their intertwined history in a chronological order. The book includes examples, homework problems, and exercises. This book can be used to teach a first course in engineering mathematics or as a refresher on basic mathematical physics. Besides serving as core textbook, this book will also appeal to undergraduate students with cross-disciplinary interests as a supplementary text or reader.

A Course in Mathematics for Students of Physics:

The Development of a Course in Mathematical Physics

Structure and Strategy

Quantum Mechanics of Atoms and Molecules

Mathematics for Physics

For physics students interested in the mathematics they use, and for math students interested in seeing how some of the ideas of their discipline find realization in an applied setting. The presentation strikes a balance between formalism and application, between abstract and concrete. The interconnections among the various topics are clarified both by the use of vector spaces as a central unifying theme, recurring throughout the book, and by putting ideas into their historical context. Enough of the essential formalism is included to make the presentation self-contained.

Mathematical Physics is an introduction to such basic mathematical structures as groups, vector spaces, topological spaces, measure spaces, and Hilbert space. Geroch uses category theory to emphasize both the interrelationships among different structures and the unity of mathematics. Perhaps the most valuable feature of the book is the illuminating intuitive discussion of the "whys" of proofs and of axioms and definitions. This book, based on Geroch’s University of Chicago course, will be especially helpful to those working in theoretical physics, including such areas as relativity, particle physics, and astrophysics.

Density Functional Theory (DFT) has firmly established itself as the workhorse for atomic-level simulations of condensed phases, pure or composite materials and quantum chemical systems. This work offers a rigorous and detailed introduction to the foundations of this theory, up to and including such advanced topics as orbital-dependent functionals as well as both time-dependent and relativistic DFT. Given the many ramifications of contemporary DFT, the text concentrates on the self-contained presentation of the basics of the most widely used DFT variants: this implies a thorough discussion of the corresponding existence theorems and effective single particle equations, as well as of key approximations utilized in implementations. The formal results are complemented by selected quantitative results, which primarily aim at illustrating the strengths and weaknesses of particular approaches or functionals. The structure and content of this book allow a tutorial and modular self-study approach: the reader will find that all concepts of many-body theory which are indispensable for the discussion of DFT - such as the single-particle Green’s function or response functions - are introduced step by step, along with the actual DFT material. The same applies to basic notions of solid state theory, such as the Fermi surface of inhomogeneous, interacting systems. In fact, even the language of second quantization is introduced systematically in an Appendix for readers without formal training in many-body theory.

A Comprehensive Course in Analysis by Poincaré Prize winner Barry Simon is a five-volume set that can serve as a graduate-level analysis textbook with a lot of additional bonus information, including hundreds of problems and numerous notes that extend the text and provide important historical background. Depth and breadth of exposition make this set a valuable reference source for almost all areas of classical analysis. Part 1 is devoted to real analysis. From one point of view, it presents the infinitesimal calculus of the twentieth century with the ultimate integral calculus (measure theory) and the ultimate differential calculus (distribution theory). From another, it shows the triumph of abstract spaces: topological spaces, Banach and Hilbert spaces, measure spaces, Riesz spaces, Polish spaces, locally convex spaces, Fréchet spaces, Schwartz space, and spaces. Finally it is the study of big techniques, including the Fourier series and transform, dual spaces, the Baire category, fixed point theorems, probability ideas, and Hausdorff dimension. Applications include the constructions of nowhere differentiable functions, Brownian motion, space-filling curves, solutions of the moment problem, Haar measure, and equilibrium measures in potential theory.

Mathematical Methods in the Physical Sciences

A Comprehensive Guide

Quantum Mechanics of Large Systems

A Course in Mathematical Physics 3

The book assumes next to no prior knowledge of the topic. The first part introduces the core mathematics, always in conjunction with the physical context. In the second part of the book, a series of examples showcases some of the more conceptually advanced areas of physics, the presentation of which draws on the developments in the first part. A large number of problems helps students to hone their skills in using the presented mathematical methods. Solutions to the problems are available to instructors on an associated password-protected website for lecturers.

What sets this volume apart from other mathematics texts is its emphasis on mathematical tools commonly used by scientists and engineers to solve real-world problems. Using a unique approach, it covers intermediate and advanced material in a manner appropriate for undergraduate students. Based on author Bruce Kusse’s course at the Department of Applied and Engineering Physics at Cornell University, Mathematical Physics begins with essentials such as vector and tensor algebra, curvilinear coordinate systems, complex variables, Fourier series, Fourier and Laplace transforms, differential and integral equations, and solutions to Laplace’s equations. The book moves on to explain complex topics that often fall through the cracks in undergraduate programs, including the Dirac delta-function, multivalued complex functions using branch cuts, branch points and Riemann sheets, contravariant and covariant tensors, and an introduction to group theory. This expanded second edition contains a new appendix on the calculus of variation -- a valuable addition to the already superb collection of topics on offer. This is an ideal text for upper-level undergraduates in physics, applied physics, physical chemistry, biophysics, and all areas of engineering. It allows physics professors to prepare students for a wide range of employment in science and engineering and makes an excellent reference for scientists and engineers in industry. Worked out examples appear throughout the book and exercises follow every chapter. Solutions to the odd-numbered exercises are available for lecturers at www.wiley-vch.de/textbooks/.

Market_Desc: · Physicists and Engineers- Students in Physics and Engineering Special Features: · Covers everything from Linear Algebra, Calculus, Analysis, Probability and Statistics, to ODE, PDE, Transforms and more- Emphasizes intuition and computational abilities- Expands the material on DE and multiple integrals- Focuses on the applied side, exploring material that is relevant to physics and engineering- Explains each concept in clear, easy-to-understand steps About The Book: The book provides a comprehensive introduction to the areas of mathematical physics. It combines all the essential math concepts into one compact, clearly written reference. This book helps readers gain a solid foundation in the many areas of mathematical methods in order to achieve a basic competence in advanced physics, chemistry, and engineering.

Devoted to the foundation of mechanics, namely classical Newtonian mechanics, the subject is based mainly on Galileo’s principle of relativity and Hamilton’s principle of least action. The exposition is simple and leads to the most complete direct means of solving problems in mechanics. The final sections on adiabatic invariants have been revised and augmented. In addition a short biography of L D Landau has been inserted.

An Invitation to Mathematical Physics and Its History

Classical Dynamical Systems

Introduction to Mathematical Physics

Groups, Hilbert Space and Differential Geometry

Density Functional Theory

This book combines the enlarged and corrected editions of both volumes on classical physics of Thirring’s famous course in mathematical physics. With numerous examples and remarks complementing the text, it is suitable as a textbook for students of physics, mathematics, and applied mathematics. The treatment of classical dynamical systems employs analysis on manifolds to provide the mathematical setting for discussions of Hamiltonian systems; problems discussed in detail include nonrelativistic motion of particles and systems, relativistic motion in electromagnetic and gravitational fields, and the structure of black holes. The treatment of classical fields used differential geometry to examine both Maxwell’s and Einstein’s equations with new material added on gauge theories.

Kompakt und verständlich führt dieses Lehrbuch in die Grundlagen der theoretischen Physik ein. Dabei werden die üblichen Themen der Grundvorlesungen Mechanik, Elektrodynamik, Relativitätstheorie, Quantenmechanik, Thermodynamik und Statistik in einem Band zusammengefasst, um den Zusammenhang zwischen den einzelnen Teilgebieten besonders zu betonen. Ein Kapitel mit mathematischen Grundlagen der Physik erleichtert den Einstieg. Zahlreiche Übungsaufgaben dienen der Vertiefung des Stoffes.

Based on the author’s junior-level undergraduate course, this introductory textbook is designed for a course in mathematical physics. Focusing on the physics of oscillations and waves, A Course in Mathematical Methods for Physicists helps students understand the mathematical techniques needed for their future studies in physics. It takes a bottom-up

The last decade has seen a considerable renaissance in the realm of classical dynamical systems, and many things that may have appeared mathematically overly sophisticated at the time of the first appearance of this textbook have since become the everyday tools of working physicists. This new edition is intended to take this development into account. I have also tried to make the book more readable and to eradicate errors. Since the first edition already contained plenty of material for a one semester course, new material was added only when some of the original could be dropped or simplified. Even so, it was necessary to expand the chapter with the proof of the K-A-M Theorem to make allowances for the current trend in physics. This involved not only the use of more refined mathematical tools, but also a reevaluation of the word "fundamental." What was earlier dismissed as a grubby calculation is now seen as the consequence of a deep principle. Even Kepler’s laws, which determine the radii of the planetary orbits, and which used to be passed over in silence as mystical nonsense, seem to point the way to a truth unattainable by superficial observation: The ratios of the radii of Platonic solids to the radii of inscribed Platonic solids are irrational, but satisfy algebraic equations of lower order.

Bridge Course In Mathematical Physics

Classical Field Theory

Mathematical physics, an advanced course

A Course in Mathematical Physics 1

Mathematical Physics

This textbook, available in two volumes, has been developed from a course taught at Harvard over the last decade. The course covers principally the theory and physical applications of linear algebra and of the calculus of several variables, particularly the exterior calculus. The authors adopt the 'spiral method' of teaching, covering the same topic several times at increasing levels of sophistication and range of application. Thus the reader develops a deep, intuitive understanding of the subject as a whole, and an appreciation of the natural progression of ideas. Topics covered include many items previously dealt with at a much more advanced level, such as algebraic topology (introduced via the analysis of electrical networks), exterior calculus, Lie derivatives, and star operators (which are applied to Maxwell's equations and optics). This then is a text which breaks new ground in presenting and applying sophisticated mathematics in an elementary setting. Any student, interpreted in the widest sense, with an interest in physics and mathematics, will gain from its study.

In this third volume of A Course in Mathematical Physics I have attempted not simply to introduce axioms and derive quantum mechanics from them, but also to progress to relevant applications. Reading the axiomatic litera ture often gives one the impression that it largely consists of making refined axioms, thereby freeing physics from any trace of down-to-earth residue and cutting it off from simpler ways of thinking. The goal pursued here, however, is to come up with concrete results that can be compared with experimental facts. Everything else should be regarded only as a side issue, and has been chosen for pragmatic reasons. It is precisely with this in mind that I feel it appropriate to draw upon the most modern mathematical methods. Only by their means can the logical fabric of quantum theory be woven with a smooth structure; in their absence, rough spots would . inevitably appear, especially in the theory of unbounded operators, where the details are too intricate to be comprehended easily. Great care has been taken to build up this mathematical weaponry as completely as possible, as it is also the basic arsenal of the next volume. This means that many proofs have been tucked away in the exercises. My greatest concern was to replace the ordinary cal culations of uncertain accuracy with better ones having error bounds, in order to raise the crude manners of theoretical physics to the more cultivated level of experimental physics.

This book is a comprehensive account of five extended modules covering the key branches of twentieth-century theoretical physics, taught by the author over a period of three decades to students on bachelor and master university degree courses in both physics and theoretical physics. The modules cover nonrelativistic quantum mechanics, thermal and statistical physics, many-body theory, classical field theory (including special relativity and electromagnetism), and, finally, relativistic quantum mechanics and gauge theories of quark and lepton interactions, all presented in a single, self-contained volume. In a number of universities, much of the material covered (for example, on Einstein's general theory of relativity, on the BCS theory of superconductivity, and on the Standard Model, including the theory underlying the prediction of the Higgs boson) is taught in postgraduate courses to beginning PhD students. A distinctive feature of the book is that full, step-by-step mathematical proofs of all essential results are given, enabling a student who has completed a high-school mathematics course and the first year of a university physics degree course to understand and appreciate the derivations of very many of the most important results of twentieth-century theoretical physics.

An engagingly-written account of mathematical tools and ideas, this book provides a graduate-level introduction to the mathematics used in research in physics. The first half of the book focuses on the traditional mathematical methods of physics – differential and integral equations, Fourier series and the calculus of variations. The second half contains an introduction to more advanced subjects, including differential geometry, topology and complex variables. The authors' exposition avoids excess rigor whilst explaining subtle but important points often glossed over in more elementary texts. The topics are illustrated at every stage by carefully chosen examples, exercises and problems drawn from realistic physics settings. These make it useful both as a textbook in advanced courses and for self-study. Password-protected solutions to the exercises are available to instructors at www.cambridge.org/9780521854030.

Mathematical Physics with Partial Differential Equations

A Complete Course on Theoretical Physics

Mechanics

A Course in Mathematics for Students of Physics: Volume 1

Classical Dynamical Systems and Classical Field Theory

Based on the author's junior-level undergraduate course, this introductory textbook is designed for a course in mathematical physics. Focusing on the physics of oscillations and waves, A Course in Mathematical Methods for Physicists helps students understand the mathematical techniques needed for their future studies in physics. It takes a bottom-up approach that emphasizes physical applications of the mathematics. The book offers: A quick review of mathematical prerequisites, proceeding to applications of differential equations and linear algebra Classroom-tested explanations of complex and Fourier analysis for trigonometric and special functions Coverage of vector analysis and curvilinear coordinates for solving higher dimensional problems Sections on nonlinear dynamics, variational calculus, numerical solutions of differential equations, and Green's functions The third edition of this highly acclaimed undergraduate textbook is suitable for teaching all the mathematics for an undergraduate course in any of the physical sciences. As well as lucid descriptions of all the topics and many worked examples, it contains over 800 exercises. New stand-alone chapters give a systematic account of the 'special functions' of physical science, cover an extended range of practical applications of complex variables, and give an introduction to quantum operators. Further tabulations, of relevance in statistics and numerical integration, have been added. In this edition, half of the exercises are provided with hints and answers and, in a separate manual available to both students and their teachers, complete worked solutions. The remaining exercises have no hints, answers or worked solutions and can be used for unaided homework; full solutions are available to instructors on a password-protected web site, www.cambridge.org/9780521679718.

Pure and Applied Mathematics, Volume 56: Partial Differential Equations of Mathematical Physics provides a collection of lectures related to the partial differentiation of mathematical physics. This book covers a variety of topics, including waves, heat conduction, hydrodynamics, and other physical problems. Comprised of 30 lectures, this book begins with an overview of the theory of the equations of mathematical physics that has its object the study of the integral, differential, and functional equations describing various natural phenomena. This text then examines the linear equations of the second order with real coefficients. Other lectures consider the Lebesgue–Fubini theorem on the possibility of changing the order of integration in a multiple integral. This book discusses as well the Dirichlet problem and the Neumann problem for domains other than a sphere or half-space. The final lecture deals with the properties of spherical functions. This book is a valuable resource for mathematicians.

A Course in Theoretical Physics

A Course in Modern Mathematical Physics

A practical course

Applications and Problems

Real Analysis: A Comprehensive Course in Analysis, Part 1