Course In Mathematical Physics

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 intro ductory courses. In order to be able to cover a suitable amount of advanced materil;ll 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 pre dictions 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 rela tivistic quantum theory, have not yet matured from the stage of rules for calculations to mathematically well understood disciplines, and are there fore 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 mathe matics.

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, relativis- tic 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.

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.

As a limit theory of quantum mechanics, classical dynamics comprises a large variety of phenomena, from computable (integrable) to chaotic (mixing) behavior. This book presents the KAM (Kolmogorov-Arnold-Moser) theory and asymptotic completeness in classical scattering. Including a wealth of fascinating examples in physics, it offers not only an excellent selection of basic topics, but also an introduction to a number of current areas of research in the field of classical mechanics. Thanks to the didactic structure and concise appendices, the presentation is self-contained and requires only knowledge of the basic courses in mathematics. The book addresses the needs of graduate and senior undergraduate students in mathematics and physics, and of researchers interested in approaching classical mechanics from a modern point of view.

A Course in Modern Mathematical PhysicsGroups, Hilbert Space and Differential GeometryCambridge University Press

Designed as a reference as well as a junior- or senior-level textbook, this book is designed to help physics undergraduates acquire an appreciation of the mathematical basis of physical theories and achieve the expected level of competence in mathematical manipulations. It comprises topics prerequisite to the study of the standard undergraduate courses in physics, and topics for advanced students, including vector calculus, matrices, and Fourier series and transforms.

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.

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/.

Indispensable for students of modern physics, this text provides the necessary background in mathematics for the study of electromagnetic theory and quantum mechanics. Clear discussions explain the particulars of vector algebra, matrix and tensor algebra, vector calculus, functions of a complex variable, integral transforms, linear differential equations, and partial differential equations. This volume collects under one cover the mathematical ideas formerly available only by taking many separate courses. It offers in-depth treatments, with a minimum of mathematical formalism. Suitable for students of physics, allied sciences, and engineering, its only prerequisites are a course in introductory physics and a course in calculus. Examples at the end of each chapter reinforce many important techniques developed in the text, and numerous graded problems make this volume suitable for independent study.

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 small book is meant as an introduction for school students graduating from Grade 10 to Grade 11/12. The basic mathematics will come in handy not just in Physics but also in certain parts of Chemistry and Computer Science. The matter has been explained Lucidly and has numerous examples, worksheets and assignments to hone the skills. Answers to many question are given at the end of each module.

The theory of partial differential equations of mathematical physics has been one of the most important fields of study in applied mathematics. This is essentially due to the frequent occurrence of partial differential equations in many branches of natural sciences and engineering. The present lecture notes have been written for the purpose of presenting an approach based mainly on the mathematical problems and their related solutions. The primary concern, therefore, is not with the general theory, but to provide students with the fundamental concepts, the underlying principles, and the techniques and methods of solution of partial differential equations of mathematical physics. One of the authors main goals is to present a fairly elementary and complete introduction to this subject which is suitable for the "first reading" and accessible for students of different specialities. The material in these lecture notes has been developed and extended from a set of lectures given at Saratov State University and reflects partially the research interests of the authors. It is intended for graduate and advanced undergraduate students in applied mathematics, computer sciences, physics, engineering, and other specialities. The prerequisites for its study are a standard basic course in mathematical analysis or advanced calculus, including elementary ordinary differential equations. Although various differential equations and problems considered in these lecture notes are physically motivated, a knowledge of the physics involved is not necessary for understanding the mathematical aspects of the solution of these problems.

The extensive application of modern mathematical teehniques to theoretical and mathematical physics requires a fresh approach to the course of equations of mathematical physics. This is especially true with regards to such a fundamental concept as the 80lution of a boundary value problem. The concept of a generalized solution considerably broadens the field of problems and enables solving from a unified position the most interesting problems that cannot be solved by applying elassical methods. To this end two new courses have been written at the Department of Higher Mathematics at the Moscow Physics anrl Technology Institute, namely, "Equations of Mathematical Physics" by V. S. Vladimirov and "Partial Differential Equations" by V. P. Mikhailov (both books have been translated into English by Mir Publishers, the first in 1984 and the second in 1978). The present collection of problems is based on these courses and amplifies them considerably. Besides the classical boundary value problems, we have ineluded a large number of boundary value problems that have only generalized solutions.

Solution of these requires using the methods and results of various branches of modern analysis. For this reason we have ineluded problems in Lebesgue in tegration, problems involving function spaces (especially spaces of generalized differentiable functions) and generalized functions (with Fourier and Laplace transforms), and integral equations.

This book combines the enlarged and corrected editions of both volumes on classical physics stemming from Thirrings famous course. The treatment of classical dynamical systems uses analysis on manifolds to provide the mathematical setting for discussions of Hamiltonian systems, canonical transformations, constants of motion, and perturbation theory. Problems discussed 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 uses the language of differential geometry, treating both Maxwells and Einsteins equations in a compact and clear fashion. The book includes discussions of the electromagnetic field due to known charge distributions and in the presence of conductors, as well as a new section on gauge theories. It discusses the solutions of the Einstein equations for maximally symmetric spaces and spaces with maximally symmetric submanifolds, and concludes by applying these results to the life and death of stars. Numerous examples and accompanying remarks make this an ideal textbook.

The aim of the present book is to demontstrate the basic methods for solving the classical linear problems in mathematical physics of elliptic, parabolic and hyperbolic type.

Publisher Description

This text is designed for an intermediate-level, two-semester undergraduate course in mathematical physics. It provides an accessible account of most of the current, important mathematical tools required in physics these days. It is assumed that the reader has an adequate preparation in general physics and calculus. The book bridges the gap between an introductory physics course and more advanced courses in classical mechanics, electricity and magnetism, quantum mechanics, and thermal and statistical physics. The text contains a large number of worked examples to illustrate the mathematical techniques developed and to show their relevance to physics. The book is designed primarily for undergraduate physics majors, but could also be used by students in other subjects, such as engineering, astronomy and mathematics.

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-u

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.

In the past decade the language and methods ofmodern 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 willbe the professors ofthe 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 suffi cientlyclear to qualify them for the minimum amount ofknowledge required by a theoretician. It is with much regret that I had to refrain from in corporating 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.

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

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 demontstrate 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.
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In this final volume I have tried to present the subject of statistical mechanics in accordance with the basic principles of the series. The effort again entailed following Gustav Mahler's maxim, "Tradition = Schlamperei" (i.e., filth) and clearing away a large portion of this tradition-laden area. The result is a book with little in common with most other books on the subject. The ordinary perturbation-theoretic calculations are not very useful in this field. Those methods have never led to propositions of much substance. Even when perturbation series, which for the most part never converge, can be given some asymptotic meaning, it cannot be determined how close the nth order approximation comes to the exact result. Since analytic solutions of nontrivial problems are beyond human capabilities, for better or worse we must settle for sharp bounds on the quantities of interest, and can at most strive to make the degree of accuracy satisfactory.