

Selected Solutions for *An Introduction to Tensors and Group Theory for Physicists, 2nd ed.*

October 3, 2018

Introduction

This is an incomplete, evolving solutions manual to [Jee15]. Note that this is the second edition of this text, and that exercise and problem numbering differs between editions. Solutions posted here have primarily been written by students in courses I taught in the UC Berkeley Physics department between 2012 and 2016. If you are interested in improving existing solutions or adding new ones of your own, please email me at nadirj@princeton.edu.

1 A Quick Introduction to Tensors

2 Vector Spaces

Exercise 2.1 : Verify equation 2.7, which states

$$\Delta_{S^2} Y(\theta, \phi) = -l(l+1)Y(\theta, \phi).$$

Solution: Pick a vector $f \in \mathcal{H}_l(\mathbb{R}^3)$. This function has two useful properties: in spherical coordinates, we may write our function as $f(r, \theta, \phi) = r^l Y(\theta, \phi)$ – this is a property of $P_l(\mathbb{R}^3)$, which contains $\mathcal{H}_l(\mathbb{R}^3)$ as a subspace. And, since we have chosen it from $\mathcal{H}_l(\mathbb{R}^3)$, it satisfies $\Delta f = 0$. We write the Laplacian explicitly and combine terms

$$\begin{aligned}\Delta f &= \left(\frac{\partial^2}{\partial r^2} + \frac{2}{r} \frac{\partial}{\partial r} + \frac{1}{r^2} \Delta_{S^2} \right) r^l Y(\theta, \phi) \\ &= l(l-1)r^{l-2}Y + \frac{2}{r}lr^{l-1}Y + r^{l-2}\Delta_{S^2}Y \\ &= l(l-1)r^{l-2}Y + 2lr^{l-2}Y + r^{l-2}\Delta_{S^2}Y \\ &= l(l+1)r^{l-2}Y + r^{l-2}\Delta_{S^2}Y\end{aligned}$$

But we know this quantity is equal to zero. Therefore,

$$\Delta_{S^2} Y(\theta, \phi) = -l(l+1)Y(\theta, \phi)$$

as claimed. Thus all harmonic l -degree polynomials correspond to a matching spherical harmonic, which corresponds to the restriction of the said polynomial to the unit sphere.

Exercise 2.3 : Given a vector v and a finite basis $\mathcal{B} = \{e_i\}_{i=1, \dots, n}$, show that the expression of v as a linear combination of the e_i is unique.

Solution: Suppose that our representation of v in the basis \mathcal{B} is explicitly given by $v = a^i e_i$, where the a^i are scalars in the appropriate field. Now, suppose that there exists another representation of v in the same basis, given by $v = b^i e_i$. Then we may write:

$$\begin{aligned}v - v &= 0 \\ &= a^i e_i - b^i e_i \\ &= (a^i - b^i) e_i\end{aligned}$$

Group Theory Solutions Manual

David M. Bishop



Group Theory Solutions Manual:

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groups symmetric groups subgroups homomorphisms isomorphism and Abelian groups The last part of the book introduces SAGE a mathematical software that is used to solve group theory problems Here most of the important commands in SAGE are explained and many examples and exercises are provided Solutions Manual to Accompany Physical Chemistry for the Life Sciences C. A. Trapp, M. P. Cady, 2011 This solutions manual contains fully worked solutions to all end of chapter discussion questions and exercises featured in Physical Chemistry for the Life Sciences **Numerical Methods for Scientists and Engineers** Richard W. Hamming, Richard Wesley Hamming, 1986-01-01 This inexpensive paperback edition of a groundbreaking text stresses frequency approach in coverage of algorithms polynomial approximation Fourier approximation exponential approximation and other topics Revised and enlarged 2nd edition *Solutions Manual to Accompany Elements of Physical Chemistry* C. A. Trapp, M. P. Cady, 2007 The Solutions manual to accompany Elements of Physical Chemistry 4e contains full worked solutions to all end of chapter exercises featured in the book **Symmetry, Broken Symmetry, and Topology in Modern Physics** Mike Guidry, Yang Sun, 2022-03-31 Written for use in teaching and for self study this book provides a comprehensive and pedagogical introduction to groups algebras geometry and topology It assimilates modern applications of these concepts assuming only an advanced undergraduate preparation in physics It provides a balanced view of group theory Lie algebras and topological concepts while emphasizing a broad range of modern applications such as Lorentz and Poincar invariance coherent states quantum phase transitions the quantum Hall effect topological matter and Chern numbers among many others An example based approach is adopted from the outset and the book includes worked examples and informational boxes to illustrate and expand on key concepts 344 homework problems are included with full solutions available to instructors and a subset of 172 of these problems have full solutions available to students **Instructor's Solutions Manual** Bradley W. Jackson, 1990 *A Course in Formal Languages, Automata and Groups* Ian M. Chiswell, 2008-11-14 This book is based on notes for a master s course given at Queen Mary University of London in the 1998 9 session Such courses in London are quite short and the course consisted essentially of the material in the first three chapters together with a two hour lecture on connections with group theory Chapter 5 is a considerably expanded version of this For the course the main sources were the books by Hopcroft and Ullman 20 by Cohen 4 and by Epstein et al 7 Some use was also made of a later book by Hopcroft and Ullman 21 The ulterior motive in the first three chapters is to give a rigorous proof that various notions of recursively enumerable language are equivalent Three such notions are considered These are generated by a type 0 grammar recognised by a Turing machine deterministic or not and defined by means of a Godel numbering having defined recursively enumerable for sets of natural numbers It is hoped that this has been achieved without too many arguments using complicated notation This is a problem with the entire subject and it is important to understand the idea of the proof which is often quite simple Two particular places that are heavy going are the proof at the end of Chapter 1 that a language recognised by a Turing machine is type 0 and the proof in Chapter 2 that a

Turing machine computable function is partial recursive

Group Theory and Chemistry David M. Bishop, 1993-01-14

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Buildings Peter Abramenko, Kenneth S. Brown, 2008-12-16 This text started out as a revised version of Buildings by the second named author 53 but it has grown into a much more voluminous book The earlier book was intended to give a short friendly elementary introduction to theory accessible to readers with a minimal background Moreover it approached buildings from only one point of view sometimes called the old fashioned approach A building is a simplicial complex with certain properties The current book includes all the material of the earlier one but we have added a lot In particular we have included the modern or W metric approach to buildings which looks quite different from the old fashioned approach but is equivalent to it This has become increasingly important in the theory and applications of buildings We have also added a thorough treatment of the Moufang property which occupies two chapters And we have added many new exercises and illustrations Some of the exercises have hints or solutions in the back of the book A more extensive set of solutions is available in a separate solutions manual which may be obtained from Springer s Mathematics Editorial Department We have tried to add the new material in such a way that readers who are content with the old fashioned approach can still get an elementary treatment of it by reading selected chapters or sections In particular many readers will want to omit the optional sections marked with a star The introduction below provides more detailed guidance to the reader

Handbook of Mathematics for Engineers and Scientists Andrei D. Polyanin, Alexander V. Manzhirov, 2006-11-27 Covering the main fields of mathematics this handbook focuses on the methods used for obtaining solutions of various classes of mathematical equations that underlie the mathematical modeling of numerous phenomena and processes in science and technology The authors describe formulas methods equations and solutions that are frequently used in scientific and engineering applications and present classical as well as newer solution methods for various mathematical equations The book supplies numerous examples graphs figures and diagrams and contains many results in tabular form including finite sums and series and exact solutions of differential integral and functional equations

Physical Chemistry Peter Atkins, Julio de Paula, Ronald Friedman, 2014 This title takes an innovative molecular approach to the teaching of physical chemistry The authors present the subject in a rigorous but accessible manner allowing students to gain a thorough understanding of physical chemistry

Elements of Advanced Mathematics, Third Edition Steven G. Krantz, 2012-03-19 For many years this classroom tested best selling text has guided mathematics students to more advanced studies in topology abstract algebra and real analysis Elements of Advanced Mathematics Third Edition retains the content and character of previous editions while making the material more up to date and significant This third edition adds four new chapters on point set topology theoretical computer science the P NP problem and zero knowledge proofs and RSA encryption The topology chapter builds

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