

# INTRODUCTION TO GRAPH THEORY

## SECOND EDITION (2001)

### SOLUTION MANUAL

SUMMER 2005 VERSION

© DOUGLAS B. WEST

MATHEMATICS DEPARTMENT

UNIVERSITY OF ILLINOIS

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### NOTICE

This is the Summer 2005 version of the Instructor's Solution Manual for *Introduction to Graph Theory*, by Douglas B. West. A few solutions have been added or clarified since last year's version.

Also present is a (slightly edited) annotated syllabus for the one-semester course taught from this book at the University of Illinois.

This version of the Solution Manual contains solutions for 99.4% of the problems in Chapters 1–7 and 93% of the problems in Chapter 8. The author believes that only Problems 4.2.10, 7.1.36, 7.1.37, 7.2.39, 7.2.47, and 7.3.31 in Chapters 1–7 are lacking solutions here. Those problems are too long or difficult for this text or use concepts not covered in the text; they will be deleted in the third edition.

The positions of solutions that have not yet been written into the files are occupied by the statements of the corresponding problems. These problems retain the (+), (0), (+), (+) indicators. Also (+) is added to introduce the statements of problems without other indicators. Thus every problem whose solution is not included is marked by one of the indicators, for ease of identification.

The author hopes that the solutions contained herein will be useful to instructors. The level of detail in solutions varies. Instructors should feel free to write up solutions with more or less detail according to the needs of the class. Please do not leave solutions posted on the web.

Due to time limitations, the solutions have not been proofread or edited as carefully as the text, especially in Chapter 8. Please send corrections to [west@math.uiuc.edu](mailto:west@math.uiuc.edu). The author thanks Fred Galvin in particular for contributing improvements or alternative solutions for many of the problems in the earlier chapters.

This will be the last version of the Solution Manual for the second edition of the text. The third edition will have many new problems, such as those posted at <http://www.math.uiuc.edu/~west/igt/newprob.html>. The effort to include all solutions will resume for the third edition. Possibly other pedagogical features may also be added later.

Inquiries may be sent to [west@math.uiuc.edu](mailto:west@math.uiuc.edu). Meanwhile, the author apologizes for any inconvenience caused by the absence of some solutions.

Douglas B. West

Mathematics Department - University of Illinois

## MATH 412

### SYLLABUS FOR INSTRUCTORS

Text: West, *Introduction to Graph Theory*, second edition, Prentice Hall, 2001.

Many students in this course see graph algorithms repeatedly in courses in computer science. Hence this course aims primarily to improve students' writing of proofs in discrete mathematics while learning about the structure of graphs. Some algorithms are presented along the way, and many of the proofs are constructive. The aspect of algorithms emphasized in CS courses is running time; in a mathematics course in graph theory from this book the algorithmic focus is on proving that the algorithms work.

Math 412 is intended as a rigorous course that challenges students to think. Homework and tests should require proofs, and most of the exercises in the text do so. The material is interesting, accessible, and applicable; most students who stick with the course will give it a fair amount of time and thought.

An important aspect of the course is the clear presentation of solutions, which involves careful writing. Many of the problems in the text have hints, either where the problem is posed or in Appendix C (or both). Producing a solution involves two main steps: finding a proof and properly writing it. It is generally beneficial to the learning process to provide "collaborative study sessions" in which students can discuss homework problems in small groups and an instructor or teaching assistant is available to answer questions and provide direction. Students should then write up clear and complete solutions on their own.

### Suggested Schedule

The subject matter for the course is the first seven chapters of the text, skipping most optional material. Modifications to this are discussed below. The 22 sections are allotted an average of slightly under two lectures each.

In the exercises, problems designated by (+) are easier or shorter than most, often good for tests or for "warmup" before doing homework problems. Problems designated by (0) are harder than most. Those designated by (0) are particularly instructive, entertaining, or important. Those designated by (+) make use of optional material.

The semester at the University of Illinois has 43 fifty-minute lectures. The final two lectures are for optional topics, usually chosen by the students from topics in Chapter 8.

|           |                        |     |
|-----------|------------------------|-----|
| Chapter 1 | Fundamental Concepts   | 8   |
| Chapter 2 | Trees and Distance     | 5.5 |
| Chapter 3 | Matchings and Factors  | 5.5 |
| Chapter 4 | Connectivity and Paths | 6   |
| Chapter 5 | Graph Coloring         | 6   |
| Chapter 6 | Planar Graphs          | 5   |
| Chapter 7 | Edges and Cycles       | 5   |
| -         | Total                  | 41  |

### Optional Material

No later material requires material marked optional. The "optional" marking also suggests to students that the final examination will not cover that material.

The optional subsections on Disjoint Spanning Trees (Bridge-10) in Section 2.1 and Stable Matchings in Section 3.2 are always quite popular with the students. The planarity algorithm (without proof) in 6.2 is appealing to students, as is the notion of embedding graphs on the torus through Example 6.3.21. Our course usually includes these four items.

The discussion of  $k$ -factors in Section 3.3 is also very instructive and

# Grimaldi Solution Manual Graph Theory

**Chartrand G Staff, Gary Chartrand**



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Introduction To Graph Theory: Solutions Manual Khee-meng Koh, Fengming Dong, Eng Guan Tay, 2007-10-12 This is a companion to the book *Introduction to Graph Theory* World Scientific 2006 The student who has worked on the problems will find the solutions presented useful as a check and also as a model for rigorous mathematical writing For ease of reference each chapter recaps some of the important concepts and or formulae from the earlier book Introduction To Graph Theory: With Solutions To Selected Problems Khee-meng Koh, Fengming Dong, Eng Guan Tay, 2023-12-05 Graph theory is an area in discrete mathematics which studies configurations called graphs involving a set of vertices interconnected by edges This book is intended as a general introduction to graph theory The book builds on the verity that graph theory even at high school level is a subject that lends itself well to the development of mathematical reasoning and proof This is an updated edition of two books already published with World Scientific i e *Introduction to Graph Theory* H3 Mathematics *Introduction to Graph Theory Solutions Manual* The new edition includes solutions and hints to selected problems This combination allows the book to be used as a textbook for undergraduate students Professors can select unanswered problems for tutorials while students have solutions for reference Introduction to Graph Theory Khee Meng Koh, F. M. Dong, Dong Fengming, Tay Eng Guan, 2007 This is a companion to the book *Introduction to Graph Theory* World Scientific 2006 The student who has worked on the problems will find the solutions presented useful as a check and also as a model for rigorous mathematical writing For ease of reference each chapter recaps some of the important concepts and or formulae from the earlier book Introduction to Graph Theory Robin J. Wilson, W. J. Wingate, 1986-05 Books in Print , 1977 *Solutions Manual to Accompany Discrete and Combinatorial Mathematics* Ralph P. Grimaldi, 1985 **Subject Guide to Books in Print** , 1975 **Scientific and Technical Aerospace Reports** , 1995 **Graphs & Digraphs** Gary Chartrand, Linda Lesniak, Ping Zhang, 2016 *Graphs Digraphs* masterfully employs student friendly exposition clear proofs abundant examples and numerous exercises to provide an essential understanding of the concepts theorems history and applications of graph theory Fully updated and thoughtfully reorganized to make reading and locating material easier for instructors and students the Sixth Edition of this bestselling classroom tested text Adds more than 160 new exercises Presents many new concepts theorems and examples Includes recent major contributions to long standing conjectures such as the Hamiltonian Factorization Conjecture 1 Factorization Conjecture and Alspach s Conjecture on graph decompositions Supplies a proof of the perfect graph theorem Features a revised chapter on the probabilistic method in graph theory with many results integrated throughout the text At the end of the book are indices and lists of mathematicians names terms symbols and useful references There is also a section giving hints and solutions to all odd numbered exercises A complete solutions manual is available with qualifying course adoption *Graphs Digraphs* Sixth Edition remains the consummate text for an advanced undergraduate level or introductory graduate level course or two semester sequence on graph theory exploring the subject s fascinating history while covering a host of

interesting problems and diverse applications      A Beginner's Guide to Graph Theory W.D. Wallis, 2010-05-05 Graph theory continues to be one of the fastest growing areas of modern mathematics because of its wide applicability in such diverse disciplines as computer science engineering chemistry management science social science and resource planning Graphs arise as mathematical models in these fields and the theory of graphs provides a spectrum of methods of proof This concisely written textbook is intended for an introductory course in graph theory for undergraduate mathematics majors or advanced undergraduate and graduate students from the many fields that benefit from graph theoretic applications This second edition includes new chapters on labeling and communications networks and small worlds as well as expanded beginner's material in the early chapters including more examples exercises hints and solutions to key problems Many additional changes improvements and corrections resulting from classroom use and feedback have been added throughout With a distinctly applied flavor this gentle introduction to graph theory consists of carefully chosen topics to develop graph theoretic reasoning for a mixed audience Familiarity with the basic concepts of set theory along with some background in matrices and algebra and a little mathematical maturity are the only prerequisites      Solutions Manual for Graphs and Digraphs Fourth Edition Chartrand G Staff, Gary Chartrand, 2006-06      A First Course in Graph Theory Gary Chartrand, Ping Zhang, 2013-05-20 Written by two prominent figures in the field this comprehensive text provides a remarkably student friendly approach Its sound yet accessible treatment emphasizes the history of graph theory and offers unique examples and lucid proofs 2004 edition      Graphs & Digraphs, Fifth Edition Gary Chartrand, Linda Lesniak, Ping Zhang, 2010-10-19 Continuing to provide a carefully written thorough introduction Graphs Digraphs Fifth Edition expertly describes the concepts theorems history and applications of graph theory Nearly 50 percent longer than its bestselling predecessor this edition reorganizes the material and presents many new topics New to the Fifth Edition New or expanded coverage of graph minors perfect graphs chromatic polynomials nowhere zero flows flows in networks degree sequences toughness list colorings and list edge colorings New examples figures and applications to illustrate concepts and theorems Expanded historical discussions of well known mathematicians and problems More than 300 new exercises along with hints and solutions to odd numbered exercises at the back of the book Reorganization of sections into subsections to make the material easier to read Bolded definitions of terms making them easier to locate Despite a field that has evolved over the years this student friendly classroom tested text remains the consummate introduction to graph theory It explores the subject's fascinating history and presents a host of interesting problems and diverse applications      Graph Theory Jonathan L. Gross, Jay Yellen, 2004      **Mathematical Modeling for the Marketplace** Helen Christensen, 1988      **A First Course in Graph Theory and Combinatorics** Sebastian M. Cioabă, 2009-05-15 The concept of a graph is fundamental in mathematics since it conveniently encodes diverse relations and facilitates combinatorial analysis of many complicated counting problems In this book the authors have traced the origins of graph theory from its humble beginnings of recreational mathematics to

its modern setting for modeling communication networks as is evidenced by the World Wide Web graph used by many Internet search engines This book is an introduction to graph theory and combinatorial analysis It is based on courses given by the second author at Queen s University at Kingston Ontario Canada between 2002 and 2008 The courses were aimed at students in their final year of their undergraduate program     Exercises in Graph Theory O. Melnikov,V. Sarvanov,R. I. Tyshkevich,2014-01-15     *Graph Theory, Combinatorics, and Algorithms* Y. Alavi,Allen Schwenk,1995     **Graph Theory with Applications** C. Vasudev,2006 Over 1500 problems are used to illustrate concepts related to different topics and introduce applications Over 1000 exercises in the text with many different types of questions posed Precise mathematical language is used without excessive formalism and abstraction Care has been taken to balance the mix of notation and words in mathematical statements Problem sets are stated clearly and unambiguously and all are carefully graded for various levels of difficulty This text has been carefully designed for flexible use     *Graph Theory, Combinatorics, and Applications* Yousef Alavi,G. Chartrand,O. R. Oellermann,A. J. Schwenk,1991-03-28

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