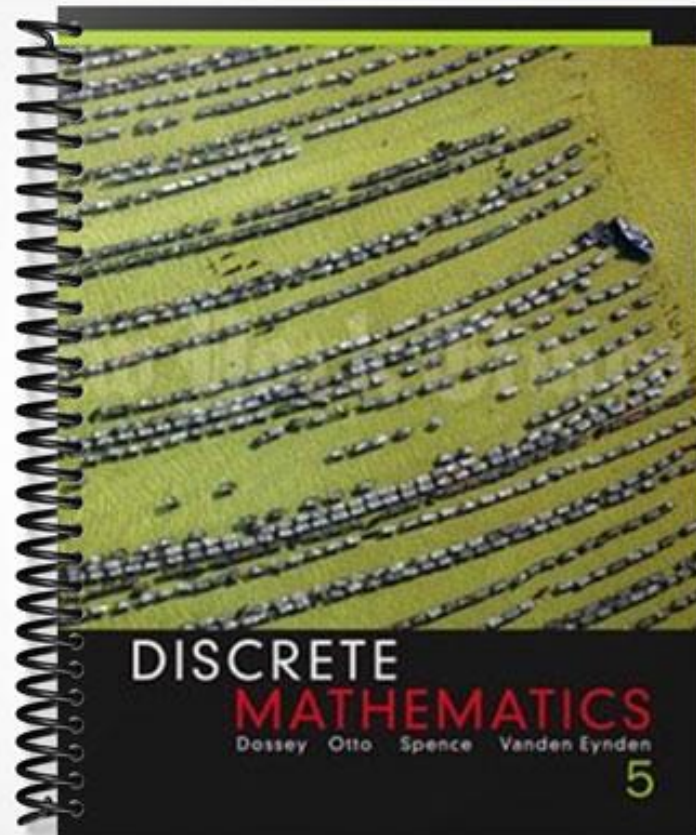


SOLUTIONS MANUAL



DISCRETE
MATHEMATICS
Dossey Otto Spence Vanden Eynden
5

INSTRUCTOR'S SOLUTIONS MANUAL

DISCRETE MATHEMATICS

FIFTH EDITION

John A. Dossey

Illinois State University

Albert D. Otto

Illinois State University

Lawrence E. Spence

Illinois State University

Charles Vanden Eynden

Illinois State University



Boston San Francisco New York
London Toronto Sydney Tokyo Singapore Madrid
Mexico City Munich Paris Cape Town Hong Kong Montreal

Provided by Pearson Addison-Wesley from electronic files supplied by the author.

Copyright © 2006 Pearson Education, Inc.

Publishing as Pearson Addison-Wesley, 75 Arlington Street, Boston, MA 02116.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America.

ISBN 0-321-30516-7

1 2 3 4 5 6 XXX 08 07 06 05



Contents

| | | |
|----------|---|-----------|
| 1 | An Introduction to Combinatorial Problems and Techniques | 1 |
| 1.1 | The Time to Complete a Project | 1 |
| 1.2 | A Matching Problem | 4 |
| 1.3 | A Knapsack Problem | 4 |
| 1.4 | Algorithms and Their Efficiency | 4 |
| | Supplementary Exercises | 5 |
| | | |
| 2 | Sets, Relations, and Functions | 6 |
| 2.1 | Set Operations | 6 |
| 2.2 | Equivalence Relations | 7 |
| 2.3 | Partial Ordering Relations | 8 |
| 2.4 | Functions | 10 |
| 2.5 | Mathematical Induction | 11 |
| 2.6 | Applications | 11 |
| | Supplementary Exercises | 12 |
| | | |
| 3 | Coding Theory | 14 |
| 3.1 | Congruence | 14 |
| 3.2 | The Euclidean Algorithm | 15 |
| 3.3 | The RSA Method | 17 |
| 3.4 | Error-Detecting and Error-Correcting Codes | 17 |
| 3.5 | Matrix Codes | 18 |
| 3.6 | Matrix Codes That Correct All Single-Digit Errors | 19 |
| | Supplementary Exercises | 20 |

Table of Contents

| | | |
|----------|--|-----------|
| 4 | Graphs | 22 |
| 4.1 | Graphs and Their Representations | 22 |
| 4.2 | Paths and Circuits | 24 |
| 4.3 | Shortest Paths and Distance | 27 |
| 4.4 | Coloring a Graph | 28 |
| 4.5 | Directed Graphs and Multigraphs | 30 |
| | Supplementary Exercises | 34 |
| | | |
| 5 | Trees | 36 |
| 5.1 | Properties of Trees | 36 |
| 5.2 | Spanning Trees | 38 |
| 5.3 | Depth-First Search | 40 |
| 5.4 | Rooted Trees | 42 |
| 5.5 | Binary Trees and Traversals | 46 |
| 5.6 | Optimal Binary Trees and Binary Search Trees | 51 |
| | Supplementary Exercises | 60 |
| | | |
| 6 | Matching | 63 |
| 6.1 | Systems of Distinct Representatives | 63 |
| 6.2 | Matchings in Graphs | 63 |
| 6.3 | A Matching Algorithm | 66 |
| 6.4 | Applications of the Algorithm | 66 |
| 6.5 | The Hungarian Method | 67 |
| | Supplementary Exercises | 67 |
| | | |
| 7 | Network Flows | 68 |
| 7.1 | Flows and Cuts | 68 |
| 7.2 | A Flow Augmentation Algorithm | 70 |
| 7.3 | The Max-Flow Min-Cut Theorem | 73 |
| 7.4 | Flows and Matchings | 74 |
| | Supplementary Exercises | 75 |

| | | |
|-----------|--|------------|
| 8 | Counting Techniques | 78 |
| 8.1 | Pascal's Triangle and the Binomial Theorem | 78 |
| 8.2 | Three Fundamental Principles | 78 |
| 8.3 | Permutations and Combinations | 79 |
| 8.4 | Arrangements and Selections with Repetitions | 79 |
| 8.5 | Probability | 80 |
| 8.6 | The Principle of Inclusion-Exclusion | 81 |
| 8.7 | Generating Permutations and r -Combinations | 82 |
| | Supplementary Exercises | 82 |
| | | |
| 9 | Recurrence Relations and Generating Functions | 84 |
| 9.1 | Recurrence Relations | 84 |
| 9.2 | The Method of Iteration | 88 |
| 9.3 | Linear Difference Equations with Constant Coefficients | 91 |
| 9.4* | Analyzing the Efficiency of Algorithms with Recurrence Relations | 94 |
| 9.5 | Counting with Generating Functions | 99 |
| 9.6 | The Algebra of Generating Functions | 100 |
| | Supplementary Exercises | 102 |
| | | |
| 10 | Combinatorial Circuits and Finite State Machines | 105 |
| 10.1 | Logical Gates | 105 |
| 10.2 | Creating Combinatorial Circuits | 107 |
| 10.3 | Karnaugh Maps | 109 |
| 10.4 | Finite State Machines | 111 |
| | Supplementary Exercises | 115 |

Table of Contents

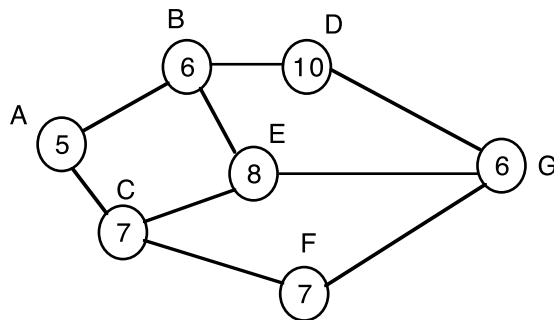
| | |
|---|------------|
| Appendices | 120 |
| A An Introduction to Logic and Proof | 120 |
| A.1 Statements and Connectives | 120 |
| A.2 Logical Equivalence | 121 |
| A.3 Methods of Proof | 125 |
| Supplementary Exercises | 127 |
| B Matrices | 130 |

Chapter 1

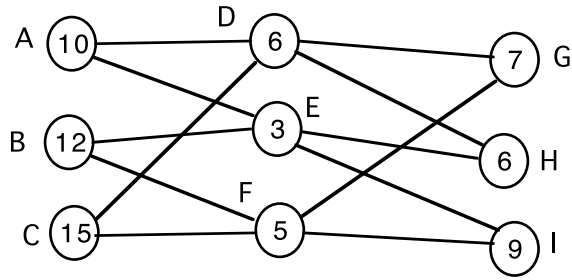
An Introduction to Combinatorial Problems and Techniques

1.1 THE TIME TO COMPLETE A PROJECT

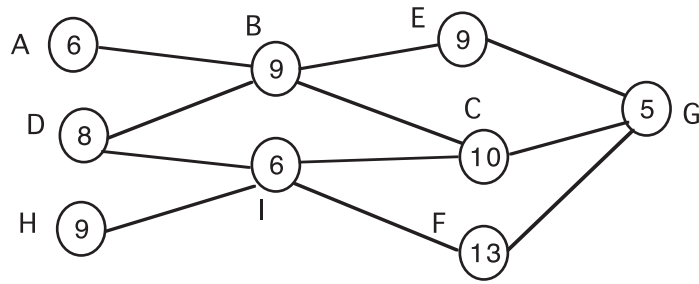
- 2. 31; A-B-E-G
- 4. 39; A-C-G-H
- 6. 16; B-D-F-H
- 8. 27; A-D-E-H
- 10. 27; A-B-D-G



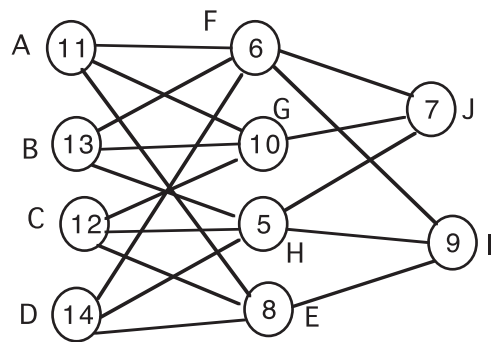
12. 29; C-F-I



14. 33; H-I-F-G



16. 31; D-E-I



18. 20 minutes

16.

| k | j | a_1 | a_2 | a_3 |
|-----|-----|-------|-------|-------|
| 3 | | 1 | 1 | 1 |
| 2 | | 1 | 1 | 1 |
| 1 | | 1 | 1 | 1 |
| 0 | | 1 | 1 | 1 |

18.

| k | j | a_1 | a_2 | a_3 | a_4 |
|-----|-----|-------|-------|-------|-------|
| 4 | | 1 | 1 | 1 | 0 |
| | | 1 | 1 | 1 | 1 |

20. The circled numbers in the table below indicated the items being compared.

| a_1 | a_2 | a_3 | a_4 | j | k |
|-------|-------|-------|-------|-----|-----|
| 23 | 5 | 17 | 12 | 1 | 3 |
| 23 | 5 | 12 | 17 | | 2 |
| 23 | 5 | 12 | 17 | | 1 |
| 5 | 23 | 12 | 17 | 2 | 3 |
| 5 | 23 | 12 | 17 | | 2 |
| 5 | 12 | 23 | 17 | 3 | 3 |
| 5 | 12 | 17 | 23 | | |

22. The circled numbers in the table below indicated the items being compared.

| a_1 | a_2 | a_3 | a_4 | a_5 | j | k |
|-------|-------|-------|-------|-------|-----|-----|
| 88 | 2 | 75 | 10 | 48 | 1 | 4 |
| 88 | 2 | 75 | 10 | 48 | | 3 |
| 88 | 2 | 10 | 75 | 48 | | 2 |
| 88 | 2 | 10 | 75 | 48 | | 1 |
| 2 | 88 | 10 | 75 | 48 | 2 | 4 |
| 2 | 88 | 10 | 48 | 75 | | 3 |
| 2 | 88 | 10 | 48 | 75 | | 2 |
| 2 | 10 | 88 | 48 | 75 | 3 | 4 |
| 2 | 10 | 88 | 48 | 75 | | 3 |
| 2 | 10 | 48 | 88 | 75 | 4 | 4 |
| 2 | 10 | 48 | 75 | 88 | | |

24. 6.5 years, 2.7 seconds

26. 2.3×10^{10} years, 12.5 seconds

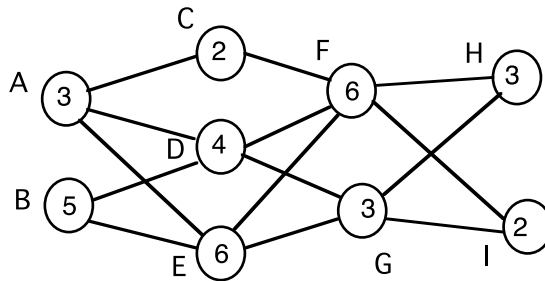
28. $4n - 3$

30. $3n - 2$

32. $-4, -4, 41, 95$

SUPPLEMENTARY EXERCISES

2. 20; B-E-F-H



4. 336

6. 40

8. 14040

10. T

12. F

14. T

16. T

18. 16

20. no

22. yes; 0

24. $-5, 7, 7, 88$

26. $\emptyset, \{4\}, \{3\}, \{3, 4\}, \{2\}, \{2, 4\}, \{2, 3\}, \{2, 3, 4\}, \{1\}, \{1, 4\}, \{1, 3\}, \{1, 3, 4\}, \{1, 2\}, \{1, 2, 4\}, \{1, 2, 3\}, \{1, 2, 3, 4\}$

28. 4.92×10^8 years

30. 4

32. $4r - 3$