

# Problems in Operator Theory

**Y. A. Abramovich**  
**C. D. Aliprantis**

**Graduate Studies  
in Mathematics**  
**Volume 51**



**American Mathematical Society**

# Problems in Operator Theory

*This page intentionally left blank*

# Problems in Operator Theory

Y. A. Abramovich

*Indiana University-Purdue University Indianapolis*

C. D. Aliprantis

*Purdue University*

Graduate Studies  
in Mathematics

Volume 51



American Mathematical Society  
Providence, Rhode Island



## Editorial Board

Walter Craig  
Nikolai Ivanov  
Steven G. Krantz  
David Saltman (Chair)

2000 *Mathematics Subject Classification*. Primary 46Axx, 46Bxx, 46Gxx, 47Axx, 47Bxx, 47Cxx, 47Dxx, 47Lxx, 28Axx, 28Exx, 15A48, 15A18.

---

## Library of Congress Cataloging-in-Publication Data

Abramovich, Y. A. (Yuri A.)

Problems in operator theory / Y. A. Abramovich, C. D. Aliprantis.

p. cm. — (Graduate studies in mathematics, ISSN 1065-7339 ; v. 51)

Includes bibliographical references and index.

ISBN 0-8218-2147-4 (alk. paper)

I. Operator theory—Problems, exercises, etc. I. Aliprantis, Charalambos D. II. Abramovich, Y. A. (Yuri A.). Invitation to operator theory. III. Title. IV. Series.

QA329 .A27 2002  
515'.724'076—dc21

2002074421

---

**Copying and reprinting.** Individual readers of this publication, and nonprofit libraries acting for them, are permitted to make fair use of the material, such as to copy a chapter for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews, provided the customary acknowledgment of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Acquisitions Department, American Mathematical Society, 201 Charles Street, Providence, Rhode Island 02904-2294, USA. Requests can also be made by e-mail to [reprint-permission@ams.org](mailto:reprint-permission@ams.org).

© 2002 by the American Mathematical Society. All rights reserved.

The American Mathematical Society retains all rights  
except those granted to the United States Government.

Printed in the United States of America.

⊗ The paper used in this book is acid-free and falls within the guidelines  
established to ensure permanence and durability.

Visit the AMS home page at <http://www.ams.org/>

10 9 8 7 6 5 4 3 2 1 07 06 05 04 03 02

To the Memory of our Parents

*This page intentionally left blank*

---

# Contents

Foreword	xi
Chapter 1. Odds and Ends	1
§1.1. Banach Spaces, Operators, and Linear Functionals	1
§1.2. Banach Lattices and Positive Operators	20
§1.3. Bases in Banach Spaces	31
§1.4. Ultrapowers of Banach Spaces	44
§1.5. Vector-valued Functions	48
§1.6. Fundamentals of Measure Theory	51
Chapter 2. Basic Operator Theory	63
§2.1. Bounded Below Operators	63
§2.2. The Ascent and Descent of an Operator	68
§2.3. Banach Lattices with Order Continuous Norms	71
§2.4. Compact and Weakly Compact Positive Operators	78
Chapter 3. Operators on $AL$ - and $AM$ -spaces	87
§3.1. $AL$ - and $AM$ -spaces	87
§3.2. Complex Banach Lattices	96
§3.3. The Center of a Banach Lattice	105
§3.4. The Predual of a Principal Ideal	111
Chapter 4. Special Classes of Operators	119
§4.1. Finite-rank Operators	119
§4.2. Multiplication Operators	125

---

§4.3. Lattice and Algebraic Homomorphisms	129
§4.4. Fredholm Operators	134
§4.5. Strictly Singular Operators	139
Chapter 5. Integral Operators	145
§5.1. The Basics of Integral Operators	145
§5.2. Abstract Integral Operators	154
§5.3. Conditional Expectations and Positive Projections	169
§5.4. Positive Projections and Lattice-subspaces	180
Chapter 6. Spectral Properties	189
§6.1. The Spectrum of an Operator	189
§6.2. Special Points of the Spectrum	197
§6.3. The Resolvent of a Positive Operator	201
§6.4. Functional Calculus	205
Chapter 7. Some Special Spectra	215
§7.1. The Spectrum of a Compact Operator	215
§7.2. Turning Approximate Eigenvalues into Eigenvalues	222
§7.3. The Spectrum of a Lattice Homomorphism	230
§7.4. The Order Spectrum of an Order Bounded Operator	232
§7.5. The Essential Spectrum of a Bounded Operator	237
Chapter 8. Positive Matrices	243
§8.1. The Banach Lattices $M_n(\mathbb{R})$ and $M_n(\mathbb{C})$	243
§8.2. Operators on Finite Dimensional Spaces	251
§8.3. Matrices with Non-negative Entries	262
§8.4. Irreducible Matrices	265
§8.5. The Perron–Frobenius Theorem	268
Chapter 9. Irreducible Operators	273
§9.1. Irreducible and Expanding Operators	273
§9.2. Ideal Irreducibility and the Spectral Radius	283
§9.3. Band Irreducibility and the Spectral Radius	290
§9.4. Krein Operators and $C(\Omega)$ -spaces	293
Chapter 10. Invariant Subspaces	299
§10.1. A Smorgasbord of Invariant Subspaces	299
§10.2. The Lomonosov Invariant Subspace Theorem	307



---

§10.3. Invariant Ideals for Positive Operators	310
§10.4. Invariant Subspaces of Families of Positive Operators	317
§10.5. Compact-friendly Operators	320
§10.6. Positive Operators on Banach Spaces with Bases	329
§10.7. Non-transitive Algebras	331
Chapter 11. The Daugavet Equation	335
§11.1. The Daugavet Equation and Uniform Convexity	335
§11.2. The Daugavet Property in $AL$ - and $AM$ -spaces	352
§11.3. The Daugavet Property in Banach Spaces	356
§11.4. The Daugavet Property in $C(\Omega)$ -spaces	359
§11.5. Slices and the Daugavet Property	365
§11.6. Narrow Operators	369
§11.7. Some Applications of the Daugavet Equation	372
Bibliography	375
Index	379



---

# Foreword

This book contains complete solutions to the more than six hundred exercises in the authors' book: **An Invitation to Operator Theory**, American Mathematical Society, 2002. The problems have been spread over eleven chapters following the format of that book. Each problem is identified by a triplet of numbers  $x.y.z$ ;  $x$  designates the chapter,  $y$  the section, and  $z$  the exercise. For instance, Problem 3.4.7 indicates Exercise 7 in Section 4 of Chapter 3.

All solutions are based on the material covered in the text with frequent references to the results in the text. For example, a reference to Theorem 5.9 refers to Theorem 5.9 and a reference to Example 6.21 refers to Example 6.21 in the book **An Invitation to Operator Theory**. We have added an extra amount of material to many solutions in order to make this book as self-contained as possible.

This problem book will be beneficial to students only if they use it "properly," that is to say, if students look at a solution of a problem *only after* trying very hard to solve the problem. Students will do themselves great injustice by reading a solution without any prior attempt on the problem. It should be a real challenge to students to produce solutions which are different from the ones presented here.

Due to the extra material incorporated into the problems, the book can be used as a companion supplement to any text used for the standard functional analysis graduate courses. In addition, this solution book can be used as a reference not only for mathematical subjects but also for other disciplines that rely on functional analytic or measure theoretic techniques.

We would like to express our most sincere thanks to all people who made constructive comments and corrections regarding the text and the problems. Special thanks are due to Professors Arkady Kitover and Vladimir Troitsky who read the solutions and made numerous suggestions and corrections. A final thank you goes to Arlene O'Sean, the AMS Copy Editor, for her excellent job in editing the manuscript.

Y. A. Abramovich and C. D. Aliprantis

Indianapolis and West Lafayette, May 2002

---

# Bibliography

1. Y. A. Abramovich, Some theorems on normed lattices, *Vestnik Leningr. Univ. Mat. Meh. Astronom.* no. 13 (1971), 5–11. (English translation: *Vestnik Leningr. Univ. Math.* 4 (1977), 153–159.)
2. Y. A. Abramovich, C. D. Aliprantis, and O. Burkinshaw, Local quasinilpotence, cycles and invariant subspaces, in: *Interaction between Functional Analysis, Harmonic Analysis, and Probability* (N. Kalton, E. Saab, and S. Montgomery-Smith, eds.), Lecture Notes in Pure and Applied Mathematics, **175**, Marcel Dekker, New York, 1995, pp. 1–12.
3. Y. A. Abramovich, C. D. Aliprantis, and W. R. Zame, A representation theorem for Riesz spaces and its applications to economics, *Economic Theory* **5** (1995), 527–535.
4. C. D. Aliprantis and K. C. Border, *Infinite Dimensional Analysis: A Hitchhikers Guide*, 2<sup>nd</sup> Edition, Springer–Verlag, Heidelberg and New York, 1999.
5. C. D. Aliprantis and O. Burkinshaw, *Locally Solid Riesz Spaces*, Academic Press, New York and London, 1978.
6. C. D. Aliprantis and O. Burkinshaw, *Positive Operators*, Academic Press, New York and London, 1985.
7. C. D. Aliprantis and O. Burkinshaw, *Principles of Real Analysis*, 3<sup>rd</sup> Edition, Academic Press, New York and London, 1998.
8. C. D. Aliprantis and O. Burkinshaw, *Problems in Real Analysis*, 2<sup>nd</sup> Edition, Academic Press, New York and London, 1998.
9. C. D. Aliprantis, O. Burkinshaw, and P. Kranz, On lattice properties of the composition operator, *Manuscripta Math.* **36** (1981), 19–31.
10. T. Andô, Contractive projections in  $L_p$ -spaces, *Pacific J. Math.* **17** (1966), 391–405.
11. T. Andô, Banachverbände und positiver Projektionen, *Math. Z.* **109** (1969), 121–130.
12. S. I. Ansari, Essential disjointness and the Daugavet equation, *Houston J. Math.* **19** (1993), 587–601.
13. W. Arendt, Über das spektrum regularer operatoren, Ph.D. Dissertation, University of Tübingen, 1979.
14. N. Aronszajn and K. T. Smith, Invariant subspaces of completely continuous operators, *Ann. of Math.* **60** (1954), 345–350.



15. W. B. Arveson and J. Feldman, A note on invariant subspaces, *Michigan Math. J.* **15** (1968), 61–64.
16. A. Benedek and R. Panzone, The spaces with mixed norm, *Duke Math. J.* **28** (1961), 301–324.
17. A. R. Bernstein and A. Robinson, Solution of an invariant subspace problem of K. T. Smith and P. R. Halmos, *Pacific J. Math.* **16** (1966), 421–431.
18. C. Bessaga and A. Pelczynski, On bases and unconditional convergence of series in Banach spaces, *Studia Math.* **17** (1958), 151–164.
19. E. Bishop and R. R. Phelps, The support functionals of a convex set, in: V. Klee ed., *Convexity* (Proceedings of Symposia in Pure Mathematics, **7**, Amer. Math. Soc., Providence, RI, 1963), 27–35.
20. A. V. Bukhvalov, V. B. Korotkov, A. G. Kusraev, S. S. Kutateladze, and B. M. Makarov, *Vector Lattices and Integral Operators*, Nauka, Novosibirsk, 1992. (English translation edited by S. S. Kutateladze was published by Kluwer Academic Publishers, Dordrecht and Boston, 1996.)
21. V. Caselles, On irreducible operators on Banach lattices, *Indag. Math.* **48** (1986), 11–16.
22. J. A. Clarkson, Uniformly convex spaces, *Trans. Amer. Math. Soc.* **40** (1936), 396–414.
23. J. Diestel, H. Jarchow, and A. Tong, *Absolutely Summing Operators*, Cambridge Studies in Advanced Mathematics, **43**, Cambridge University Press, 1995.
24. J. Diestel and J. J. Uhl, Jr., *Vector Measures*, Math. Surveys, **15**, Amer. Math. Soc., Providence, Rhode Island, 1977.
25. P. G. Dodds and D. H. Fremlin, Compact operators in Banach lattices, *Israel J. Math.* **34** (1979), 287–320.
26. P. G. Dodds, C. B. Huijsmans, and B. de Pagter, Characterizations of conditional expectation-type operators, *Pacific J. Math.* **141** (1990), 55–77.
27. R. G. Douglas, *Banach Algebra Techniques in Operator Theory*, Academic Press, New York and London, 1972.
28. N. Dunford and J. T. Schwartz, *Linear Operators I*, Wiley (Interscience), New York, 1958.
29. Z. Ercan and S. Onal, Invariant subspaces for positive operators acting on a Banach space with Markushevich basis, *Positivity*, forthcoming.
30. V. Gantmacher, Über schwache totalstetige operatoren, *Mat. Sb. (N.S.)* **7** (49) (1940), 301–308.
31. S. A. Gershgorin, Über die Albrechtung Eigenwerte einer Matrix, *Izv. Akad. Nauk SSSR Ser. Fiz.-Mat.* **6** (1931), 749–754.
32. W. T. Gowers and B. Maurey, The unconditional sequence problem, *J. Amer. Math. Soc.* **6** (1993), 851–874.
33. W. T. Gowers and B. Maurey, Banach spaces with small spaces of operators, *Math. Ann.* **307** (1997), 541–568.
34. J. J. Grobler, Band irreducible operators, *Indag. Math.* **48** (1986), 405–409.
35. A. Grothendieck, Une caractérisation vectorielle métrique des espaces  $L^1$ , *Canad. J. Math.* **7** (1955), 552–561.
36. A. Grothendieck, Produits tensoriels topologiques et espaces nucléaires, *Mem. Amer. Math. Soc.*, **16**, 1965.
37. F. L. Hernández and B. Rodríguez-Salinas, On  $\ell^p$ -complimented copies in Orlicz spaces II, *Israel J. Math.* **68** (1989), 27–55.

38. R. B. Honor, Density and transitivity results on  $\ell^\infty$  and  $\ell^1$ , *J. London Math. Soc.* **32** (1985), 521–527.
39. R. C. James, Weakly compact sets, *Trans. Amer. Math. Soc.* **113** (1964), 129–140.
40. V. M. Kadets, Some remarks concerning the Daugavet equation, *Quaestiones Math.* **19** (1996), 225–235.
41. V. M. Kadets and M. M. Popov, On the Liapunov convexity theorem with applications to sign-embeddings, *Ukrainian Math. J.* **44** (1992), 1192–1200.
42. V. M. Kadets and M. M. Popov, The Daugavet property for narrow operators in rich subspaces of  $C[0, 1]$  and  $L_1[0, 1]$ , *St. Petersburg Math. J.* **8** (1997), 571–584.
43. V. M. Kadets, R. V. Shvidkoy, G. G. Sirotkin, and D. Werner, Banach spaces with the Daugavet property, *Trans. Amer. Math. Soc.* **352** (2000), 855–873.
44. G. K. Kalisch, On similarity, reducing manifolds, and unitary equivalences of certain Volterra operators, *Ann. of Math.* **66** (1957), 481–494.
45. L. V. Kantorovich and G. P. Akilov, *Functional Analysis*, Pergamon Press, Oxford and New York, 1982.
46. L. V. Kantorovich, B. Z. Vulikh, and A. G. Pinsker, *Functional Analysis in Partially Ordered Spaces*, Gostekhizdat, Moscow and Leningrad, 1950.
47. R. Khalil, The Daugavet equation in vector-valued function spaces, *Panamer. Math. J.* **6** (1996), 51–53.
48. J. Kim, The characterization of a lattice homomorphism, *Canadian J. Math.* **27** (1975), 172–175.
49. V. B. Korotkov, *Integral Operators*, Nauka, Novosibirsk, 1983.
50. C.-S. Lin, Generalized Daugavet equations and invertible operators on uniformly convex Banach spaces, *J. Math. Anal. Appl.* **197** (1996), 518–528.
51. J. Lindenstrauss and L. Tzafriri, On the complemented subspaces problem, *Israel J. Math.* **9** (1971), 263–269.
52. J. Lindenstrauss and L. Tzafriri, *Classical Banach Spaces I*, Springer-Verlag, Berlin and New York, 1977.
53. V. I. Lomonosov, A counterexample to the Bishop-Phelps theorem in complex spaces, *Israel J. Math.* **115** (2000), 25–28.
54. G. Ya. Lozanovsky, On a theorem of N. Dunford, *Izv. Vyssh. Uchebn. Zaved. Mat.* **8** (1974), 58–59. (Russian)
55. H. P. Lotz, Minimal and reflexive Banach lattices, *Trans. Amer. Math. Soc.* **211** (1975), 85–100.
56. P. Meyer-Nieberg, Quasitriangulierbare Operatoren und invariante Untervektorräume stetiger linearer Operatoren, *Arch. Math. (Basel)* **22** (1971), 186–199.
57. D. P. Milman, On some criteria for the regularity of spaces of the type (B), *Dokl. Akad. Nauk SSSR, N. S.*, **20** (1938), 243–246. (In Russian.)
58. S-T. C. Moy, Characterization of conditional expectation as a transformation on function spaces, *Pacific J. Math.* **4** (1954), 47–63.
59. J. R. Munkres, *Topology*, Prentice-Hall, Englewood Cliffs, NJ, 1975.
60. H. Nakano, *Modern Spectral Theory*, Maruzen Co., Tokyo, 1950.
61. B. de Pagter, Irreducible compact operators, *Math. Z.* **192** (1986), 149–153.
62. C. Pearcy and N. Salinas, An invariant-subspace theorem, *Michigan Math. J.* **20** (1973), 21–31.

63. A. Pelczynski, On the impossibility of embedding of the space  $L$  in certain Banach spaces, *Coll. Math.* **8** (1961), 199–203.
64. B. J. Pettis, A proof that every uniformly convex space is reflexive, *Duke Math. J.* **5** (1939), 369–374.
65. A. M. Plichko and M. M. Popov, *Symmetric function spaces on atomless probability spaces*, Dissertationes Mathematicae, **306**, 1990.
66. C. J. Read, A solution to the invariant subspace problem on the space  $\ell_1$ ; *Bulletin London Math. Soc.* **17** (1985), 305–317.
67. C. J. Read, A short proof concerning the invariant subspace problem, *J. London Math. Soc.* (2) **34** (1986), 335–348.
68. C. J. Read, Quasinilpotent operators and the invariant subspace problem, *J. London Math. Soc.* (2) **56** (1997), 595–606.
69. H. H. Schaefer, Spektraleigenschaften positiver linearer Operatoren, *Math. Z.* **82** (1963), 303–313.
70. H. H. Schaefer, *Banach Lattices and Positive Operators*, Springer-Verlag, Berlin and New York, 1974.
71. H. H. Schaefer, On theorems of de Pagter and Andô-Krieger, *Math. Z.* **192** (1986), 155–157.
72. I. Singer, *Bases in Banach Spaces*, Vol. 1, Springer-Verlag, Berlin and New York, 1970.
73. G. G. Sirotkin, Compact-friendly multiplication operators on Banach function spaces, *J. Funct. Analysis*, forthcoming.
74. V. L. Šmulian, Sur la structure de la sphere unitaire dans l'espace de Banach, *Mat. Sb. (N.S.)* **9** (1941), 545–561.
75. A. Sobczyk, Projection of the space  $m$  on its subspace  $c_0$ , *Bull. Amer. Math. Soc.* **47** (1941), 938–947.
76. A. Spalsbury, Operators not positive with respect to any basis, *Quaestiones Math.* **23** (2000), 489–494.
77. A. Taylor and D. C. Lay, *Introduction to Functional Analysis*, R. E. Krieger, Malabar, Florida, 1986.
78. T. Terzioglu, A characterization of compact linear mappings, *Arch. Math. (Basel)* **22** (1971), 76–78.
79. V. G. Troitsky, On the modulus of C. J. Read's operator, *Positivity* **3** (1998), 257–264.
80. L. Tzafriri, Remarks on contractive projections in  $L_p$ -spaces, *Israel J. Math.* **7** (1969), 9–15.
81. L. Tzafriri, An isomorphic characterization of  $L_p$ - and  $c_0$ -spaces, II, *Michigan Math. J.* **18** (1971), 21–31.
82. L. Weis and D. Werner, The Daugavet equation for operators not fixing a copy of  $C(S)$ , *J. Operator Theory* **39** (1998), 89–98.
83. A. C. Zaanen, *Riesz Spaces II*, North-Holland, Amsterdam, 1983.

---

# Index

- AL*-space, 87, 90
- AM*-compact operator, 313
- AM*-space, 87, 90
  - represented as  $L_\infty(\pi)$ , 152
  - with unit, 87
- abstract integral operator, 154
- additive semigroup of operators, 319
- adjoint of resolvent, 190
- adjoint of strictly singular operator, 142
- adjoint operator, 66
- algebra of operators, 304
  - non-transitive, 304, 305, 331
  - transitive, 306
  - unital, 304
- algebraic complement of subspace, 136
- algebraic homomorphism, 129
- analytic function, 50, 205
- annihilator, 19
  - of a set, 257
  - of a vector subspace, 19, 257
- antisymmetry property, 20
- approximate eigenvalue, 198, 222
- approximate point spectrum, 198, 232
- approximation of vectors in  $E_u$ , 104
- approximation property, 122
- Archimedean Riesz space, 22, 25, 72, 108, 212
- ascent of operator, 68, 137, 210
- atom, 72, 74, 352
  - in  $C(\Omega)$ -space, 352
- atomic Banach lattice, 282
- atomic measure space, 154
- atomless Riesz space, 73
- automatic continuity, 132
  
- backward shift, 69, 286, 311
  
- Banach function space, 154
- Banach lattice, 332
  - atomic, 282
  - complex, 96
  - with mixed norm, 163
  - with order continuous norm, 71, 76, 90, 126, 329
- Banach space
  - direct sum, 7, 195
  - quotient, 18
  - reflexive, 11, 40, 341, 367
  - renormed, 373
  - separable, 362
  - uniformly convex, 11, 338, 341, 342, 344
  - uniformly smooth, 338, 342–344
- band, 24, 72, 75, 76, 106, 159, 265, 291
  - generated by a set, 24
  - generated by a vector, 24
  - generated by an ideal, 24
  - principal, 110
  - projection, 29, 321
- band irreducibility, 290
- band irreducible operator, 273, 276, 281
  - quasinilpotent, 292
- band projection, 108
- Bartle–Dunford–Schwartz theorem, 363
- basic sequence, 39
- basis, 31, 329
  - in  $C[0, 1]$ , 37
  - in  $L_p[0, 1]$ , 34
  - in a  $B$ -space, 31, 33
  - orthogonal, 244
  - orthonormal, 244
  - unconditional, 36, 40, 329
- biorthogonal sequence, 40

- Bochner integrable function, 368  
 Borel measure, 94, 126, 231, 362  
 bounded below operator, 63
- Calkin algebra, 241  
 Carleman operator, 147  
 carrier, 31
  - of functional, 156
  - of ideal, 31
- Cayley–Hamilton theorem, 250, 258  
 center, 105
  - of  $L_p(\mu)$ , 107, 157
  - of a Banach function space, 157
  - of Banach lattice, 105, 106
- central operator, 106, 274  
 Cesaro operator, 195  
 chain of open sets, 51  
 characteristic polynomial, 245, 250, 252, 255, 256, 268  
 Clarkson's inequality, 345  
 clopen set, 26  
 closed ideal, 112  
 closest point to a set, 11  
 cofinal set, 51  
 collection of operators, 317
  - finitely quasinilpotent, 318
  - locally quasinilpotent, 317
- commutant of an operator, 304  
 commutator of two operators, 209  
 commuting Krein operators, 295  
 commuting operators, 191, 296  
 compact operator, 78, 82  
 compact-friendly operator, 321  
 compactly dominated operator, 289, 292  
 complement
  - algebraic of subspace, 136
  - of closed subspace, 121, 359
- complemented subspace, 121, 359  
 complete measure, 52  
 completely continuous function, 332  
 completeness of normed Riesz spaces, 28  
 completion
  - Dedekind, 30, 93
  - Maeda–Ogasawara–Vulikh, 108
  - norm, 112
- complex Banach lattice, 96, 243  
 complex ideal, 99  
 complex lattice homomorphism, 130  
 complexification, 3, 96, 97
  - of  $\mathbb{R}^n$ , 97
  - of  $C_{\mathbb{R}}(\Omega)$ , 97
  - of a  $B$ -lattice, 96
  - of a  $B$ -space, 227
  - of a real normed space, 4
  - of a real vector space, 3, 5
- component, 26, 77  
 composition of analytic functions, 206  
 composition operator, 83, 128, 303  
 conditional expectation operator, 169, 170  
 cone, 15, 20, 21, 329
  - generated by a Schauder basis, 329
  - generating, 21, 183
  - in a  $B$ -space, 329
  - in a normed Riesz space, 27
- conjugate, 98
  - of complex number, 98
  - of matrix, 98
- continuity of positive operators, 27, 331  
 contour, 205
  - Jordan, 205
- contraction, 64, 218  
 contractive projection, 170, 175  
 convergence
  - $*$ , 55
  - in measure, 57
  - notions in  $L_0$ , 158
  - order, 22, 53
  - ultrafilter, 45
- convex hull of components, 77  
 convolution of kernels, 162  
 countable spectrum, 197  
 countable sup property, 54  
 curve in a topological space, 50  
 cyclic vector, 260
- Daugavet equation, 335, 363, 365  
 Daugavet property, 352, 353, 356, 359, 367  
 Dedekind complete Riesz space, 26, 30, 54, 105, 108, 155, 233  
 Dedekind completion, 30, 93  
 derivatives of the resolvent function, 189  
 descent of operator, 68, 137, 210
  - finite, 138
- diagonal matrix, 109  
 diagonal projection, 109  
 diagonalizable matrix, 246  
 diagonalizing matrix, 246  
 direct sum Banach space, 7, 195  
 direct sum of operators, 306  
 direct sum operator, 195  
 Dirichlet's theorem, 186  
 discrete vector, 72  
 disjoint linear functionals, 74  
 disjoint sequence, 212  
 disjoint vectors, 74, 125  
 disjointly strictly singular operator, 144  
 disjointness of  $I$  from integral operators, 151  
 domination of operators, 100, 290, 310  
 double adjoint, 303  
 double power bounded operator, 195  
 dual of  $\ell_p$ -sum of  $B$ -spaces, 224  
 duality of  $AM$ - and  $AL$ -spaces, 88  
 Dunford's theorem, 160  
 Dunford–Pettis operator, 316



- dyadic point, 38
- $E_n^\infty$ , order continuous dual of  $E$ , 31
- eigenspace, 283
- eigenvalue, 201, 206, 240, 262  
 approximate, 198, 222
- eigenvector of matrix, 262, 267
- equivalent norms, 97
- essential singularity, 210
- essential spectrum, 237  
 of forward shift, 238
- essentially nilpotent operator, 239
- expanding operator, 273
- exposed point of a set, 367
- extension of additive function, 21
- extension of linear functional, 10
- factorization of compact operators, 82
- filter of sets, 44
- Finite Dimensional Separation Theorem, 16
- finite-rank operator, 79, 119, 123, 127, 215, 355
- finitely quasinilpotent collection, 318
- forward shift, 69, 238, 311
- Fréchet differentiability of the norm, 347
- Fredholm alternative, 138
- Fredholm operator, 134
- Frobenius' theorem, 262
- function  
 linear, 184  
 analytic, 50, 205  
 Bochner integrable, 368  
 completely continuous, 332  
 harmonic, 186  
 matrix-valued, 267  
 piecewise linear, 184  
 Rademacher, 91, 370  
 retraction, 13
- functional  
 multiplicative, 221  
 supporting set at a point, 347
- functional calculus, 205
- Gantmacher's theorem, 80
- Gateaux differentiability of the norm, 347
- generalized Harris operator, 323
- generating cone, 21, 183
- Gershgorin's theorem, 263
- Gribanov's theorem, 149
- Haar system, 34
- harmonic function, 186
- Harris operator, 293, 323
- hereditarily indecomposable  $B$ -space, 143
- Hermitian matrix, 243, 246, 249
- Hilbert space, 102
- Hilbert–Schmidt operator, 153
- homomorphism  
 algebraic, 129  
 lattice, 74, 105, 117, 129, 227, 264  
 hyperinvariant closed subspace, 283
- $\mathcal{I}(X, Y)$ , set of isomorphisms from  $X$  to  $Y$ , 67
- ideal, 99, 265  
 complex, 99  
 invariant, 310  
 null, 116, 311  
 null of an  $\ell$ -seminorm, 115  
 null of functional, 31  
 order dense, 58  
 order dense in  $L_0(\pi)$ , 58  
 principal, 90  
 range of operator, 311
- ideal irreducibility, 283
- ideal irreducible operator, 100, 273, 276
- identity operator, 160, 356
- implication scheme, 273
- independence  
 of eigenvectors, 197  
 of linear functionals, 119
- index of operator, 134, 137
- Index Theorem, 137
- inequality  
 Clarkson's, 345  
 Jensen's, 173  
 Khintchine's, 143  
 triangle, 96
- inner product preserving matrix, 244
- integral operator, 94, 145, 215, 294
- internal point of a set, 87
- interval preserving operator, 46, 132, 231, 264
- invariant ideal, 310
- invariant measure, 276
- invariant subspace, 5, 203, 299
- inverse of operator, 1, 7, 193, 232, 235
- invertible elements in a  $B$ -algebra, 237
- invertible matrix, 263
- invertible operator, 7, 193, 232, 235, 251
- irreducibility  
 band, 290  
 ideal, 283
- irreducible matrix, 265, 266
- irreducible operator, 273
- isolated point, 352, 361
- isolated point of  $\sigma(T)$ , 197, 210, 239
- isometry, 8, 353  
 lattice, 225  
 linear, 8, 142, 225
- isomorphism  
 lattice, 117
- James' theorem, 341

- Jensen's inequality, 173  
 joint continuity of composition, 10  
 joint spectral radius, 320  
 Jordan contour, 205  
  
*KB*-space, 75  
 Kadets–Klee property, 344  
 Khintchine's inequality, 143  
 Krein operator, 266, 267, 271, 273, 293  
   compact, 294  
   with positive eigenvalues, 295  
 Krein–Rutman theorem, 219  
 Kronecker's theorem, 231  
  
*L*-space, 114  
 $L_0(\mu)$ , space of measurable functions, 54  
 $L_{p,1}$ , *B*-lattice of mixed norms, 163  
 $L_{p,\infty}$ , *B*-lattice of mixed norms, 163  
 $\ell_p$ -sum of *B*-spaces, 223  
 $\mathcal{L}(X, Y)$ , the *B*-space of bounded operators, 2, 10  
 $\mathcal{L}_r(E, F)$ , the *B*-lattice of regular operators, 28  
 Lat(*T*), algebra of *T*-invariant closed subspaces, 301  
 Laplace's equation, 186  
 lattice homomorphism, 46, 74, 105, 117, 129, 132, 227, 229  
   complex, 130  
   order continuous, 133  
   spectrum, 230  
 lattice isometry, 225  
 lattice isomorphism, 117  
 lattice operations  
   in  $\mathcal{L}_r(E, F)$ , 26  
   weakly  $\sigma$ -continuous, 91  
 lattice seminorm, 115  
 lattice-subspace, 183  
   finite dimensional, 183  
 law  
   Parallelogram, 345  
 limit functional, 134  
 linear function, 184  
 linear functional  
   limit, 134  
   multiplicative, 131, 142  
 linear isometry, 8, 114, 142, 225  
 linearly independent functionals, 119  
 locally quasinilpotent collection, 317  
 locally quasinilpotent operator, 285  
 Lomonosov operator, 308  
 Lomonosov's Invariant Subspace Theorem, 307  
  
*M*-space, 113  
 Maeda–Ogasawara–Vulikh Representation Theorem, 108, 110  
  
 majorizing vector subspace, 183  
 Markov matrix, 95, 263, 269  
 Markov operator, 95, 130, 276, 308  
 Markov projection, 177  
 matrix  
   diagonal, 109  
   diagonalizable, 246  
   diagonalizing, 246  
   Hermitian, 243, 246, 249  
   inner product preserving, 244  
   invertible, 263  
   irreducible, 265, 266  
   Markov, 95, 263, 269  
   nilpotent, 249, 265  
   non-negative, 262  
   norm preserving, 244  
   positive, 262  
   positive semidefinite, 248  
   primitive, 271  
   quasinilpotent, 249  
   stochastic, 95  
   strongly positive, 262  
   unitary, 244, 246  
   upper triangularizable, 251  
   upper triangularizing, 251  
 matrix representing an operator, 6, 255  
 matrix-valued function, 267  
 maximum modulus principle, 187  
 measure, 107, 126  
   atomic, 154  
   Borel, 94, 126, 362  
   complete, 52  
   invariant, 276  
   of bounded variation, 126  
   on a semiring, 59  
   separable, 148  
 measure convergence, 57  
 measure of non-compactness, 240  
   of operator, 241  
   of set, 240  
 minimal extension, 155  
 minimal polynomial, 253  
 mixed norm, 163  
 Miyajima projection, 183  
   continuous, 185  
 modulus, 123, 262  
   of finite-rank operator, 123  
   of integral operator, 94  
   of matrix, 262  
   of regular operator, 74  
 Morera's theorem, 48  
 multiplication operator, 125, 127, 303, 307  
   weakly compact, 220  
 multiplicative linear functional, 131, 142, 221  
 multiplicative semigroup, 319  
 multiplicity of eigenvalues, 252

- Nakano's theorem, 156  
 narrow operator, 369  
 nearest point mapping, 11  
 nearest point to a set, 11  
 Neumann series, 191  
 nilpotent matrix, 249, 265  
 nilpotent operator, 70, 195  
 non-negative matrix, 262  
 non-transitive algebra, 304, 305, 331  
 norm, 1  
   Fréchet differentiable, 347  
   Gateaux differentiable, 347  
   mixed, 163  
   of integral operator, 94  
   of operator, 1  
   quotient, 18, 112  
   uniformly convex, 11  
   uniqueness in a  $B$ -lattice, 28  
 norm completion, 112, 114  
   of  $AL$ -space, 114  
   of  $AM$ -space, 113  
 norm extension, 233  
 norm of integral operator, 94  
 norm preserving matrix, 244  
 norm totally bounded set, 81  
 norming subspace, 49  
 norms on  $\mathbb{C}^n$ , 98  
 nuclear operator, 124  
 null ideal, 31, 65, 311  
   of an  $\ell$ -seminorm, 115  
   of functional, 116  
  
 one-to-one operator, 7, 251  
 operator  
    $AM$ -compact, 313  
   abstract integral, 154  
   adjoint, 66  
   band irreducible, 273, 276, 281  
   bounded below, 63  
   Carleman, 147  
   central, 106, 274  
   Cesaro, 195  
   compact, 78, 82  
   compact-friendly, 320, 321  
   compactly dominated, 289, 292  
   composition, 83, 128, 303  
   conditional expectation, 169, 170  
   contraction, 64  
   direct sum, 195  
   disjointly strictly singular, 144  
   double power bounded, 195  
   Dunford–Pettis, 316  
   essentially nilpotent, 239  
   expanding, 273  
   finite-rank, 79, 119, 123, 127, 215, 355  
   Fredholm, 134  
   generalized Harris, 323  
   Harris, 293, 323  
   Hilbert–Schmidt, 153  
   ideal irreducible, 100, 273, 276  
   identity, 151, 160, 356  
   integral, 94, 145, 215, 294  
   interval preserving, 46, 132, 231, 264  
   invertible, 7, 193, 232, 235, 251  
   irreducible, 273  
   isometry, 8  
   Krein, 266, 267, 271, 273, 293  
   locally quasinilpotent, 285  
   locally quasinilpotent but not quasinilpotent, 285  
   Lomonosov, 308  
   Markov, 95, 130, 276, 308  
   multiplication, 125, 127, 303, 307  
   narrow, 369, 372  
   nilpotent, 70, 195  
   non-strictly singular, 143  
   nuclear, 124  
   one-to-one, 7, 251  
   order continuous, 25, 202  
   polynomially compact, 307  
   power compact, 219, 239  
   principal ideal preserving, 106  
   projection, 176  
   quasinilpotent, 192, 195  
   rank-one, 127, 354, 365  
   regular, 93  
   shift, 219, 306  
   strictly positive, 127, 311  
   strictly singular, 139, 220, 240  
   strong Krein, 273  
   strongly expanding, 274, 275, 281  
   surjective, 7, 63, 226, 251  
   symmetric, 328, 339  
   Volterra, 216, 219, 331  
   weakly compact, 78, 80, 84, 220, 367  
   weakly expanding, 274  
   with closed range, 65–67, 139  
   with countable spectrum, 197  
   with separable range, 81, 362  
 operator domination, 100, 310  
 operator norm, 1  
 orbit of vector, 260  
 order closed set, 23  
 order complete lattice of invariant subspaces, 301  
 order complete Riesz space, 22  
 order completeness of  $L_0(\mu)$ , 54  
 order continuity of the norm  
   in an  $AL$ -space, 90  
 order continuous dual, 31  
   of  $L_\infty$ , 157  
 order continuous operator, 25, 202  
 order convergence, 22, 53  
 order dense ideal, 58

- order dense Riesz subspace, 54
- order interval, 92
  - weakly compact, 92
- order spectrum, 232
- order unit, 87, 125
- ordered vector space
  - Archimedean, 21
- orthogonal basis, 244
- orthogonal complement, 247
- orthomorphism, 105
- orthonormal basis, 244
  
- Parallelogram Law, 345
- partition of set, 171
- Perron–Frobenius theorem, 268, 270
- piecewise linear function, 184
- point
  - closest to a set, 11
  - dyadic, 38
  - exposed, 367
  - internal of set, 87
  - isolated, 352, 361
  - isolated of  $\sigma(T)$ , 239
  - nearest to a set, 11
  - quasi-interior, 125, 126
  - strongly exposed, 367
  - support of a set, 14
- Poisson’s formula, 186
- pole of the resolvent, 210
- polynomial
  - characteristic, 245, 250, 252, 255, 256, 268
  - minimal, 253
- polynomially compact operator, 307
- positive matrix, 262
- positive operator
  - on a  $B$ -space, 329
- positive projection, 169, 180
- positive semidefinite matrix, 248
- power compact operator, 219, 239
- primitive matrix, 271
- principal band, 110, 159
- principal ideal, 90
- principal ideal preserving operator, 106
- product rule for derivatives, 48
- projection, 29, 121, 169, 176, 179, 199
  - band, 108, 110
  - contractive, 170, 175
  - diagonal, 109
  - finite-rank operator, 121
  - Markov, 177
  - orthogonal, 179
  - positive, 180
  - spectral, 211, 239
- projection band, 321
- property
  - antisymmetry, 20
  - Daugavet, 352
  - Kadets–Klee, 344
  - reflexivity, 20
  - Schur, 84, 333
  - transitivity, 20
- pseudoinverse of operator, 139
  
- quasi-interior point, 125, 126
- quasinilpotent matrix, 249
- quasinilpotent operator, 192, 195
- quotient Banach space, 18
- quotient map, 18, 111
- quotient norm, 18, 112
  
- Rademacher functions, 91, 370
- range ideal of operator, 311
- range of operator, 66, 139
- rank of a matrix, 258
- rank-one operator, 127, 354, 365
- reducing subspace, 207
- reflexive  $B$ -space, 11, 40, 341, 367
- reflexivity property, 20
- regular operator, 93
- representation
  - Kakutani–Bohnenblust–Krein, 130
  - Maeda–Ogasawara–Vulikh, 108
  - of  $AM$ -space as  $L_\infty(\pi)$ , 152
  - of finite-rank operator, 120
  - of operator by matrix, 255
- resolvent
  - of positive operator, 201
- resolvent identity
  - second, 189
- retract of a space, 13
- retraction, 13
- Riemann–Lebesgue lemma, 91
- Riesz space, 133, 155
  - Archimedean, 22, 24, 52, 72, 108, 212
  - atomless, 73
  - Dedekind complete, 26, 30, 54, 105, 108, 155, 233
  - order complete, 22
- Riesz subspace, 110, 112
  - order dense, 54
- Riesz’s lemma, 135
- Riesz–Kantorovich formula, 26, 125
  
- $\star$ -convergence, 55
- $\mathcal{S}$ -invariant subspace, 318
- Schauder system, 37
- Schur property, 84, 333
- second resolvent identity, 189
- semigroup of operators, 319
  - additive, 319
  - multiplicative, 319
- semiring of sets, 59
- separable  $B$ -space, 362
- separable measure, 148

- separable range, 81, 362
- separation of points, 157, 183
- separation of sets, 16
- Separation Theorem
  - Finite Dimensional, 16
- sequence
  - basic, 39
  - biorthogonal, 40
  - disjoint, 212
  - weakly unconditionally Cauchy, 360
- series
  - Neumann, 191
  - unconditionally convergent, 41, 361
  - weakly unconditionally Cauchy, 360
- set
  - clopen, 26
  - cofinal, 51
  - solid, 23
  - spectral, 209, 211
  - totally bounded, 169
  - weakly compact, 84
- shift, 69
- shift operator, 219, 306
  - backward, 69, 286, 311
  - forward, 69, 238, 311
- similar matrices, 244, 255
- similar operators, 199
- similarity invariance, 121
- singularity
  - essential, 210
- slice of a set, 365
- solid set, 23
- space
  - $L$ , 114
  - $M$ , 113
  - Hilbert, 102
- special points of the spectrum, 197
- Spectral Mapping Theorem
  - for polynomials, 205
- spectral projection, 211, 239
- spectral radius, 190, 192, 283, 289, 290, 292, 294
  - joint, 320
  - of sum of operators, 202
  - Rota–Strang, 320
- spectral set, 209, 211
- spectrum, 189, 220
  - approximate, 198, 232
  - essential, 237
  - of a direct sum operator, 195
  - of compact operator, 215
  - of composition of operators, 196, 201
  - of lattice homomorphism, 230
  - of multiplication operator, 194
  - of operator, 189
  - of order bounded operator, 236
  - of projection, 199
  - of similar operators, 200
  - order, 232
  - spectrum of order bounded operator, 236
  - stochastic matrix, 95
  - strictly positive operator, 127, 311
  - strictly singular operator, 139, 220, 240
  - strong Krein operator, 273
  - strong unit, 87
  - strongly expanding operator, 274, 275, 281
  - strongly exposed point, 367
  - strongly positive matrix, 262
  - subgroup of the unit circle, 230, 231
    - dense, 231
    - finite, 230
  - subspace
    - complemented, 121
    - invariant, 5, 203
    - norming, 49
    - reducing, 207
  - subspace invariant under a collection, 318
  - subspace invariant under an operator, 5
  - subspace of an ultrapower, 46
  - sum of  $B$ -spaces, 223
  - sum of narrow operators, 370, 372
  - sum of unconditionally convergent series, 42
  - sum of vector spaces closed, 111
  - support point of a set, 14
  - supporting functional, 347
  - surjective operator, 7, 63, 226, 251
  - symmetric operator, 328, 339
- system
  - Haar, 34
  - Schauder, 37
- totally bounded set, 76, 81, 169
- trace, 120
  - of finite-rank operator, 120
  - of matrix, 244
- transformer, 132
- transitive algebra, 306
- transitivity property, 20
- transpose of matrix, 259
- triangle inequality, 96
- $\mathcal{U}$ -limit of sequence, 45
- ultrafilter, 44, 229
  - free, 229
- ultrafilter convergence, 45
- ultrapower of a  $B$ -space, 44
- unbounded component of  $\rho(T)$ , 202
- unconditional basis, 36, 40, 329
- unconditionally convergent series, 41, 361
- uniformly convex  $B$ -space, 11, 341, 342, 344
- uniformly convex norm, 11
- uniformly smooth  $B$ -space, 342–344
- uniqueness of kernel, 145
- unit, 87, 330



- order, 87, 125
  - strong, 87
  - weak, 25, 125, 126, 156, 169, 275, 330
- unital algebra, 127
- unital algebra of operators, 304
- unitary matrix, 244, 246
- upper triangularizable matrix, 251
- upper triangularizing matrix, 251
  
- vector
  - cyclic, 260
- vector sublattice, 178
  - closed, 178
  - generated by a vector space, 182
- Volterra operator, 216, 219, 331
  
- weak unit, 25, 125, 126, 169, 275, 330
  - in  $E_n^*$ , 156
- weakly compact interval, 92
- weakly compact operator, 78, 80, 84, 220, 367
- weakly compact set, 84
- weakly expanding operator, 274
- weakly sequentially continuous lattice operations, 91
- weakly unconditionally Cauchy sequence, 360
- weakly unconditionally Cauchy series, 360

## Titles in This Series

- 51 **Y. A. Abramovich and C. D. Aliprantis**, Problems in operator theory, 2002
- 50 **Y. A. Abramovich and C. D. Aliprantis**, An invitation to operator theory, 2002
- 49 **John R. Harper**, Secondary cohomology operations, 2002
- 48 **Y. Eliashberg and N. Mishachev**, Introduction to the  $h$ -principle, 2002
- 47 **A. Yu. Kitaev, A. H. Shen, and M. N. Vyalyi**, Classical and quantum computation, 2002
- 46 **Joseph L. Taylor**, Several complex variables with connections to algebraic geometry and Lie groups, 2002
- 45 **Inder K. Rana**, An introduction to measure and integration, second edition, 2002
- 44 **Jim Agler and John E. McCarthy**, Pick interpolation and Hilbert function spaces, 2002
- 43 **N. V. Krylov**, Introduction to the theory of random processes, 2002
- 42 **Jin Hong and Seok-Jin Kang**, Introduction to quantum groups and crystal bases, 2002
- 41 **Georgi V. Smirnov**, Introduction to the theory of differential inclusions, 2002
- 40 **Robert E. Greene and Steven G. Krantz**, Function theory of one complex variable, 2002
- 39 **Larry C. Grove**, Classical groups and geometric algebra, 2002
- 38 **Elton P. Hsu**, Stochastic analysis on manifolds, 2002
- 37 **Hershel M. Farkas and Irwin Kra**, Theta constants, Riemann surfaces and the modular group, 2001
- 36 **Martin Schechter**, Principles of functional analysis, second edition, 2002
- 35 **James F. Davis and Paul Kirk**, Lecture notes in algebraic topology, 2001
- 34 **Sigurdur Helgason**, Differential geometry, Lie groups, and symmetric spaces, 2001
- 33 **Dmitri Burago, Yuri Burago, and Sergei Ivanov**, A course in metric geometry, 2001
- 32 **Robert G. Bartle**, A modern theory of integration, 2001
- 31 **Ralf Korn and Elke Korn**, Option pricing and portfolio optimization: Modern methods of financial mathematics, 2001
- 30 **J. C. McConnell and J. C. Robson**, Noncommutative Noetherian rings, 2001
- 29 **Javier Duoandikoetxea**, Fourier analysis, 2001
- 28 **Liviu I. Nicolaescu**, Notes on Seiberg-Witten theory, 2000
- 27 **Thierry Aubin**, A course in differential geometry, 2001
- 26 **Rolf Berndt**, An introduction to symplectic geometry, 2001
- 25 **Thomas Friedrich**, Dirac operators in Riemannian geometry, 2000
- 24 **Helmut Koch**, Number theory: Algebraic numbers and functions, 2000
- 23 **Alberto Candel and Lawrence Conlon**, Foliations I, 2000
- 22 **Günter R. Krause and Thomas H. Lenagan**, Growth of algebras and Gelfand-Kirillov dimension, 2000
- 21 **John B. Conway**, A course in operator theory, 2000
- 20 **Robert E. Gompf and András I. Stipsicz**, 4-manifolds and Kirby calculus, 1999
- 19 **Lawrence C. Evans**, Partial differential equations, 1998
- 18 **Winfried Just and Martin Weese**, Discovering modern set theory. II: Set-theoretic tools for every mathematician, 1997
- 17 **Henryk Iwaniec**, Topics in classical automorphic forms, 1997
- 16 **Richard V. Kadison and John R. Ringrose**, Fundamentals of the theory of operator algebras. Volume II: Advanced theory, 1997
- 15 **Richard V. Kadison and John R. Ringrose**, Fundamentals of the theory of operator algebras. Volume I: Elementary theory, 1997
- 14 **Elliott H. Lieb and Michael Loss**, Analysis, 1997
- 13 **Paul C. Shields**, The ergodic theory of discrete sample paths, 1996

TITLES IN THIS SERIES

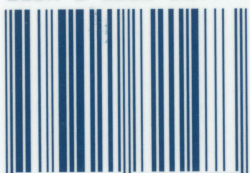
- 12 **N. V. Krylov**, Lectures on elliptic and parabolic equations in Hölder spaces, 1996
- 11 **Jacques Dixmier**, Enveloping algebras, 1996 Printing
- 10 **Barry Simon**, Representations of finite and compact groups, 1996
- 9 **Dino Lorenzini**, An invitation to arithmetic geometry, 1996
- 8 **Winfried Just and Martin Weese**, Discovering modern set theory. I: The basics, 1996
- 7 **Gerald J. Janusz**, Algebraic number fields, second edition, 1996
- 6 **Jens Carsten Jantzen**, Lectures on quantum groups, 1996
- 5 **Rick Miranda**, Algebraic curves and Riemann surfaces, 1995
- 4 **Russell A. Gordon**, The integrals of Lebesgue, Denjoy, Perron, and Henstock, 1994
- 3 **William W. Adams and Philippe Lounstau**, An introduction to Gröbner bases, 1994
- 2 **Jack Graver, Brigitte Servatius, and Herman Servatius**, Combinatorial rigidity, 1993
- 1 **Ethan Akin**, The general topology of dynamical systems, 1993

This is one of the few books available in the literature that contains problems devoted entirely to the theory of operators on Banach spaces and Banach lattices. The book contains complete solutions to the more than 600 exercises in the companion volume, *An Invitation to Operator Theory*, Volume 50 in the AMS series Graduate Studies in Mathematics, also by Abramovich and Aliprantis.

The exercises and solutions contained in this volume serve many purposes. First, they provide an opportunity to the readers to test their understanding of the theory. Second, they are used to demonstrate explicitly technical details in the proofs of many results in operator theory, providing the reader with rigorous and complete accounts of such details. Third, the exercises include many well-known results whose proofs are not readily available elsewhere. Finally, the book contains a considerable amount of additional material and further developments. By adding extra material to many exercises, the authors have managed to keep the presentation as self-contained as possible.

The book can be very useful as a supplementary text to graduate courses in operator theory, real analysis, function theory, integration theory, measure theory, and functional analysis. It will also make a nice reference tool for researchers in physics, engineering, economics, and finance.

ISBN 0-8218-2147-4



9 780821 821473

GSM/51

AMS on the Web  
[www.ams.org](http://www.ams.org)