

volume 238

A Dekker Series of Lecture Notes in Pure and Applied Mathematics

Stochastic Processes and Functional Analysis

A Volume of Recent Advances in Honor of M. M. Rao

edited by

Alan C. Krinik

Randall J. Swift

Stochastic Processes and Functional Analysis

A Volume of Recent Advances in Honor of M. M. Rao

edited by

Alan C. Krinik

Randall J. Swift

*California State Polytechnic University
Pomona, California, U.S.A.*



MARCEL DEKKER, INC.

NEW YORK • BASEL

Although great care has been taken to provide accurate and current information, neither the author(s) nor the publisher, nor anyone else associated with this publication, shall be liable for any loss, damage, or liability directly or indirectly caused or alleged to be caused by this book. The material contained herein is not intended to provide specific advice or recommendations for any specific situation.

Trademark notice: Product or corporate names may be trademarks or registered trademarks and are used only for identification and explanation without intent to infringe.

Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress.

ISBN: 0-8247-5404-2

This book is printed on acid-free paper.

Headquarters

Marcel Dekker, Inc.
270 Madison Avenue, New York, NY 10016, U.S.A.
tel: 212-696-9000; fax: 212-685-4540

Distribution and Customer Service

Marcel Dekker, Inc.
Cimarron Road, Monticello, New York 12701, U.S.A.
tel: 800-228-1160; fax: 845-796-1772

Eastern Hemisphere Distribution

Marcel Dekker AG
Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland
tel: 41-61-260-6300; fax: 41-61-260-6333

World Wide Web

<http://www.dekker.com>

The publisher offers discounts on this book when ordered in bulk quantities. For more information, write to Special Sales/Professional Marketing at the headquarters address above.

Copyright © 2004 by Marcel Dekker, Inc. All Rights Reserved.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, microfilming, and recording, or by any information storage and retrieval system, without permission in writing from the publisher.

Current printing (last digit):

10 9 8 7 6 5 4 3 2 1

PRINTED IN THE UNITED STATES OF AMERICA

Preface

An AMS Special Session in honor of M.M. Rao was held at the 2002 joint meetings of the American Mathematical Society and the Mathematical Association of America. That Special Session was on Stochastic Processes and Functional Analysis and was organized by Professors Alan C. Krinik and Randall J. Swift, both of California State Polytechnic University, Pomona.

Professor M.M. Rao has had a long and distinguished research career. His research spans the areas of probability, statistics, stochastic processes, Banach space theory, measure theory and differential equations - both deterministic and stochastic. The prolific published research of M.M. Rao impacts each of these broad areas of mathematics.

The purpose of the Special Session was to highlight the key role played by abstract analysis in simplifying and solving fundamental problems in stochastic theory. This notion is fundamental to the mathematics research of M.M. Rao, who uses functional analytic methods to bring questions in these diverse areas to light.

The Sessions were a great success, bringing together a diverse group of research mathematicians whose work has been influenced by M.M.'s work and who, in turn, have influenced his work. Not only did this diverse group of speakers benefit from the common unifying thread of the session, but also there were often lively discussions and questions from the session audience.

This volume contains most of the talks given at the Sessions as well as several that were contributed later. This collection of papers reflects the depth and enormous breadth of M.M. Rao's work. A major highlight of the Sessions was M.M.'s talk entitled "Stochastic analysis and function spaces", which was a remarkable unifying survey of recent work in the area. This volume features that talk as an article, which includes a broad bibliography of the important works in the area.

The volume begins with a biography of M.M. Rao, a complete bibliography of his published writings, a list of his Ph.D. students and, notably, a collection of essays about M.M. written by some of his Ph.D students. Many of M.M. students have remained devoted to him, decades after completing their degrees. Their loyal devotion arises from M.M.'s complete dedication

to them. He consistently put their concerns and welfare as his first priority. Their essays are a remarkable tribute.

This volume complements the Festschrift volume *Stochastic Processes and Functional Analysis*, which was published by Marcel Dekker, Inc. in 1997. That volume was in celebration of M.M.'s 65th birthday. As M.M. continues to work on, develop and expand mathematics, we look to future collections of articles that honor him and his love of mathematics.

R. J. Swift
A. C. Krinik

Biography of M. M. Rao

M.M. Rao was born Malempati Madhusudana Rao in the village of Nimmagadda in the state of Andhra Pradesh in India on June 6, 1929. He came to the United States after completing his studies at the College of Andhra University and the Presidency College of Madras University. He obtained his Ph.D in 1959 at the University of Minnesota under the supervision of Monroe Donsker (as well as Bernard R. Gelbaum, Leonid Hurwicz, and I. Richard Savage).

His first academic appointment was at Carnegie Institute of Technology (now called Carnegie Mellon University) in 1959. In 1972, he joined the faculty at the University of California, Riverside where he remains today. He has held visiting positions at the Institute for Advanced Study (Princeton), the Indian Statistical Institute, University of Vienna, University of Strassbourg, and the Mathematical Sciences Research Institute (Berkeley).

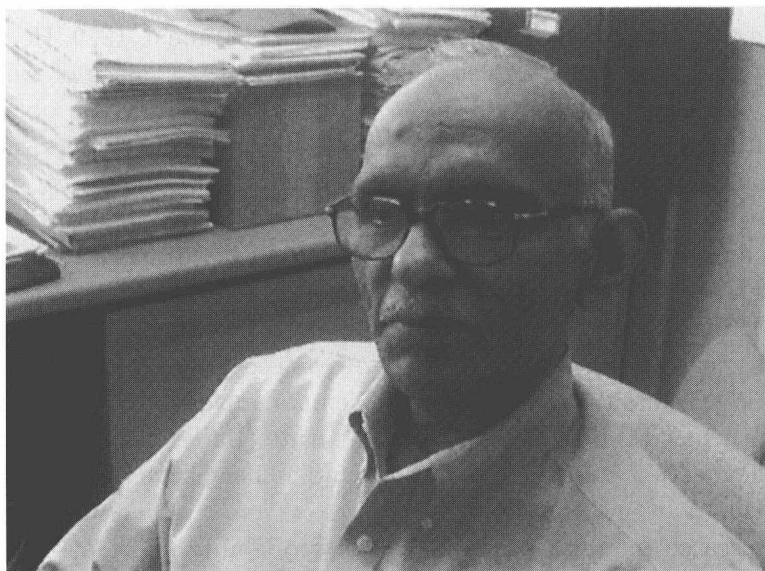
In 1966 he married Durgamba Kolluru in India. They have twin daughters Leela and Uma and one granddaughter.

M.M.'s research interests were initially in probability and mathematical statistics, but his intense mathematical interest and natural curiosity found him pursuing a wide range of mathematical analysis including stochastic processes, functional analysis, ergodic theory and related asymptotics, differential equations and difference equations. His breadth of interest is mirrored by his students, many of whom are recognized as experts in diverse fields such as measure theory, operator theory, partial differential equations and stochastic processes.

M.M. has always strived for complete understanding and generality in mathematics and rarely accepts less from others. This view of mathematics has played a central role in his teaching. M.M. Rao is truly a gifted lecturer and he has inspired many generations of students. He is a demanding Ph.D. advisor that expects the most from his students. The guidance and mentoring he provides them has led to many of his students becoming successful mathematicians. It is no wonder that he has had his share of the best available graduate students.

M.M. is a prolific writer. His first published writings were not on math-

ematics, but rather Indian poetry. He wrote poetry in his late teenage years and had a collection of his poems published when he was 21. His mathematical research publications are many and span five decades. He is active and vital as ever. He has just completed a second edition of his well-received measure theory text and is currently working upon revised and expanded second editions of his probability and conditional measures texts.



Published Writings of M. M. Rao

- [1] Note on a remark of Wald, *Amer. Math. Monthly* 65 (1958), 277-278.
- [2] Lower bounds for risk functions in estimation, *Proc. Nat'l Acad. of Sciences* 45 (1959), 1168-1171.
- [3] Estimation by periodogram, *Trabajos de Estadística* 11 (1960), 123-137.
- [4] Two probability limit theorems and an application, *Indagationes Mathematicae* 23 (1961), 551-559.
- [5] Theory of lower bounds for risk functions in estimation, *Mathematische Annalen* 143 (1961), 379-398.
- [6] Consistency and limit distributions of estimators of parameters in explosive stochastic difference equations, *Annals of Math. Stat.* 32 (1961), 195-218.
- [7] Some remarks on independence of statistics, *Trabajos de Estadística* 12 (1961), 19-26.
- [8] Remarks on a multivariate gamma distribution, *Amer. Math. Monthly* 68 (1961), (with P. R. Krishnaiah, 342-346).
- [9] Theory of order statistics, *Mathematische Annalen* 147 (1962), 298-312.
- [10] Nonsymmetric projections in Hilbert Space, *Pacific J. Math.* 12 (1962), 343-357, (with V. J. Mizel).
- [11] Characterizing normal law and a nonlinear integral equation, *J. Math. Mech.* 12 (1963), 869-880.
- [12] Inference in stochastic processes-I, *Teoria Veroyatnastei i ee Primeneniya* 8 (1963), 282-298.
- [13] Some inference theorems in stochastic processes, *Bull. Amer. Math. Soc.* 68 (1963), 72-77.
- [14] Discriminant analysis, *Annals of Inst. of Stat. Math.* 15 (1963), 11-24.
- [15] Bayes estimation with convex loss, *Annals of Math. Stat.* 34 (1963), 839-846, (with M.H. DeGroot).
- [16] Stochastic give-and-take, *J. Math. Anal. & Appl.* 7 (1963), 489-498, (with M.H. DeGroot)
- [17] Averagings and quadratic equations in operators, *Carnegie-Mellon University Technical Report # 9* (1963) 27 pages, (with V. J. Mizel)
- [18] Projections, generalized inverses, and quadratic forms, *J. Math. Anal. & Appl.* 9 (1964), 1-11, (with J. S. Chipman).

- [19] Decomposition of vector measures, *Proceedings of Nat'l. Acad. of Sciences* 51 (1964), 771-774.
- [20] Decomposition of vector measures, *Proceedings of Nat'l. Acad. of Sciences* 51 (1964), 771-774, Erratum, 52 (1964), p. 864.
- [21] Linear functionals on Orlicz spaces, *Nieuw Archief voor Wiskunde* 312 (1964), 77-98.
- [22] The treatment of linear restrictions in regression analysis, *Econometrica* 32 (1964), 198-209, (with J.S. Chipman).
- [23] Conditional expectations and closed projections, *Indagationes Mathematicae* 27 (1965), 100-112.
- [24] Smoothness of Orlicz spaces-I and II, *Indagationes Mathematicae* 27 (1965), 671-680, 681-690.
- [25] Existence and determination of optimal estimators relative to convex loss, *Annals of Inst. of Stat. Math* 17 (1965), 113-147.
- [26] Interpolation, ergodicity, and martingales, *J. of Math. & Mech.* 16 (1965), 543-567.
- [27] Inference in stochastic processes-II, *Zeitschrift fur Wahrscheinlichkeitstheorie* 5 (1966), 317-335.
- [28] Approximations to some statistical tests, *Trabajos de Estadistica* 17 (1966), 85-100.
- [29] Multidimensional information inequalities and prediction, *Proceedings of Int'l. Symposium on Multivariate Anal.*, Academic Press, (1966) 287-313, (with M.H. DeGroot).
- [30] Convolutions of vector fields and interpolation, *Proceedings of Nat'l. Acad. Sciences* 57 (1967), 222-226.
- [31] Abstract Lebesgue-Radon-Nikodym theorems, *Annali di Matematica Pura ed Applicata* (4) 76 (1967), 107-132.
- [32] Characterizing Hilbert space by smoothness, *Indagationes Mathematicae* 29 (1967), 132-135.
- [33] Notes on pointwise convergence of closed martingales, *Indagationes Mathematicae* 29 (1967), 170-176.
- [34] Inference in stochastic processes-III, *Zeitschrift fur Wahrscheinlichkeitstheorie* 8 (1967), 49-72.
- [35] Characterization and extension of generalized harmonizable random fields, *Proceedings Nat'l. Acad. Sciences* 58 (1967), 1213-1219.
- [36] Local functionals and generalized random fields, *Bull. Amer. Math. Soc.* 74 (1968), 288-293.
- [37] Extensions of the Hausdorff-Young theorem, *Israel J. of Math.* 6 (1968), 133-149.
- [38] Linear functionals on Orlicz spaces: General theory, *Pacific J. Math.* 25 (1968), 553-585.
- [39] Almost every Orlicz space is isomorphic to a strictly convex Orlicz space, *Proceedings Amer. Math. Soc.* 19 (1968), 377-379.

- [40] Predictions nonlineares et martingales d'operateurs, Comptes rendus (Academie des Sciences, Paris), Ser. A, 267 (1968) 122-124.
- [41] Representation theory of multidimensional generalized random fields, Proceedings 2d Int'l. Sympt. Multivariate Anal., Academic Press (1969), 411-436.
- [42] Operateurs de moyednes et moyennes conditionnelles, C.R. Acad. Sci-ences, Paris, Ser. A, 268 (1969), 795-797.
- [43] Produits tensoriels et espaces de fontioiis, C.R. Acad. Sci., Paris 268 (1969), 1599- 1601.
- [44] Stone-Weierstrass theorems for function spaces, J. Math. Anal. 25 (1969), 362-371.
- [45] Contractive projections and prediction operators, Bull. Amer. Math. Sec. 75 (1969), 1369-1373.
- [46] Generalized martingales, Proceedings 1st Midwestern Symp. on Ergodic Theory Prob., Lecture Notes in Math., Springer-Verlag, 160 (1970), 241-261.
- [47] Linear operations, tensor products and contractive projections in function spaces, Studia Math. 38, 131-186, Addendum 48 (1970), 307-308.
- [48] Approximately tame algebras of operators, Bull. Acad. Pol. Sci., Ser. Math. 19 (1971), 43-47.
- [49] Abstract nonlinear prediction and operator martingales, J. Multivariate Anal. 1 (1971), 129-157, Erratum, 9. p. 646.
- [50] Local functionals and generalized random fields with independent values, Teor. Vero- jatnost., Prem. 16 (1971), 466-483.
- [51] Projective limits of probability spaces, J. Multivariate Anal. 1 (1971), 28-57.
- [52] Contractive projections and conditional expectations, J. Multivariate Anal. 2 (1972), 262-381, (with N. Dinculeanu).
- [53] Prediction sequences in smooth Banach spaces, Ann. Inst. Henri Poincare, Ser. B, 8 (1972), 319-332.
- [54] Notes on characterizing Hilbert space by smoothness and smooth Orlicz spaces, J. Math. Anal. & Appl. 37 (1972), 228-234.
- [55] Abstract martingales and ergodic theory, Proc. 3rd Symp. on Multivari-ate Anal., Academic Press (1973), 100-116.
- [56] Remarks on a Radon-Nikodym theorem for vector measures, Proc. Symp. on Vector & Operator Valued Measures and Appi., Academic Press (1973), 303-317.
- [57] Inference in stochastic processes-IV: Predictors and projections, Sankhya, Ser. A 36 (1974), 63-120.
- [58] Inference in stochastic processes-V: Admissible means, Sankhya, Ser. A. 37 (1974), 538-549.
- [59] Extensions of stochastic transformations, Trab. Estadistica 26 (1975), 473-485.

- [60] Conditional measures and operators, *J. Multivariate Anal.* 5 (1975), 330-413.
- [61] Compact operators and tensor products, *Bull. Acad. Pol. Sci. Ser. Math.* 23 (1975), 1175-1179.
- [62] Two characterizations of conditional probability, *Proc. Amer. Math. Sec.* 59 (1976), 75-80.
- [63] Conjugate series, convergence and martingales, *Rev. Roum. Math. Pures et Appl.* 22 (1977), 219-254.
- [64] Inference in stochastic processes-VI: Translates and densities, *Proc. 4th Symp. Multivariate Anal.*, North Holland, (1977), 311-324.
- [65] Bistochastic operators, *Commentationes Mathematicae*, Vol. 21 March, (1978), 301- 313.
- [66] Asymptotic distribution of an estimator of the boundary parameter of an unstable process, *Ann. Statistics* 6 (1978), 185-190.
- [67] Covariance analysis of nonstationary time series, *Developments in Statistics I* (1978), 171-225.
- [68] Non L^1 -bounded martingales, *Stochastic Control Theory and Stochastic Differential Systems*, *Lecture Notes in Control and Information Sciences*, 16 (1979), 527-538, Springer Verlag.
- [69] Processus lineaires sur $C_{00}(G)$, *C. R. Acad. Sci., Paris*, 289 (1979), 139-141.
- [70] Convolutions of vector fields-I, *Math. Zeitschrift*, 174 (1980), 63-79.
- [71] Asymptotic distribution of an estimator of the boundary parameter of an unstable process, *Ann. Statistics* 6 (1978), 185-190, Correction, *Ann. Statistics* 8 (1980), 1403.
- [72] Local Functionals on $C_{00}(G)$ and probability, *J. Functional Analysis* 39 (1980), 23-41.
- [73] Local functionals, *Proceedings of Oberwolfach Conference on Measure Theory*, *Lecture Notes in Math.* 794, Springer-Verlag (1980), 484-496.
- [74] Structure and convexity of Orlicz spaces of vector fields, *Proceedings of the F.B. Jones Conference on General Topology and Modern Analysis*, University of California, Riverside (1981), 457-473.
- [75] Representation of weakly harmonizable processes, *Proc. Nat. Acad. Sci.*, 79, No. 9 (1981), 5288-5289.
- [76] Stochastic processes and cylindrical probabilities, *Sankhya*, Ser. A (1981), 149-169.
- [77] Application and extension of Cramer's Theorem on distributions of ratios, In *Contributions to Statistics and Probability*, North Holland (1981), 617-633.
- [78] Harmonizable processes: structure theory, *L'Enseignement Mathematique*, 28 (1982), 295-351.

- [79] Domination problem for vector measures and applications to non-stationary processes, Oberwolfach Measure Theory Proceedings, Springer Lecture Notes in Math. 945 (1982), 296-313.
- [80] Bimeasures and sampling theorems for weakly harmonizable processes, Stochastic Anal. Appl. 1 (1983), 21-55, (with D.K. Chang).
- [81] Filtering and smoothing of nonstationary processes, Proceedings of the ONR workshop on "Signal Processing", Marcel-Dekker Publishing (1984), 59-65.
- [82] The spectral domain of multivariate harmonizable processes, Proc. Nat. Acad. Sci. U.S.A. 81 (1984), 4611-4612.
- [83] Harmonizable, Cramér, and Karhunen classes of processes, Handbook in Vol. 5 (1985), 279-310.
- [84] Bimeasures and nonstationary processes, Real and Stochastic Analysis, Wiley & Sons (1986), 7-118, (with D.K. Chang).
- [85] A commentary on "On equivalence of infinite product measures", in S. Kakutani's selected works, Birkhauser Boston Series (1986), 377-379.
- [86] Probability, Academic Press, Inc., New York, Encyclopedia of Physical Science and Technology, Vol. 11 (1987), pp. 290-310.
- [87] Special representations of weakly harmonizable processes, Stochastic Anal. (1988), 169-189, (with D.K. Chang).
- [88] Paradoxes in conditional probability, J. Multivariate Anal., 27, (1988), pp. 434-446.
- [89] Harmonizable signal extraction, filtering and sampling Springer-Verlag, Topics in Non-Gaussian Signal Processing, Vol. II (1989), pp. 98-117.
- [90] A view of harmonizable processes, North-Holland, New York, in Statistical Data Analysis and Inference (1989), pp. 597-615.
- [91] Bimeasures and harmonizable processes; (analysis, classification, and representation), Springer-Verlag Lecture Notes in Math., 1379, (1989), pp. 254-298.
- [92] Sampling and prediction for harmonizable isotropic random fields, J. Col Analysis, Information & System Sciences, Vol 16 (1991), pp. 207-220.
- [93] $L^{2,2}$ - boundedness, harmonizability and filtering, Stochastic Anal. App., (1992), pp. 323-342.
- [94] Probability (expanded for 2nd ed.), Encyclopedia of Physical Science and Technology Vol 13 (1992), pp. 491-512.
- [95] Stochastic integration: a unified approach, C. R. Acad. Sci., Paris, Vol 314 (Series 1), (1992), pp. 629-633.
- [96] A projective limit theorem for probability spaces and applications, Theor. Prob. and Appl., Vol 38 (1993), (with V. V. Sazonov, in Russian), pp. 345-355.
- [97] Exact evaluation of conditional expectations in the Kolmogorov model, Indian J. Math., Vol 35 (1993) pp 57-70.

- [98] An approach to stochastic integration (a generalized and unified treatment) in *Multivariate Analysis: Future Directions*, Elsevier Science Publishers, The Netherlands (1993), pp. 347-374.
- [99] Harmonizable processes and inference: unbiased prediction for stochastic flows, *J. Statistic. Planning and Inf.*, Vol 39 (1994), pp. 187-209.
- [100] Some problems of real and stochastic analysis arising from applications, *Stochastic Processes and Functional Analysis*, J. A. Goldstein, N. E. Gretskey, J.J. Uhl, editors, Marcel Dekker Inc. (1997), 1-15.
- [101] Packing in Orlicz sequence spaces, (with Z. D. Ren), *Studia Math.* 126 (1997), no. 3, 235-251.
- [102] Second order nonlinear stochastic differential equations, *Nonlinear Analysis*, Vol. 30, no. 5 (1997) 3147-3151.
- [103] Higher order stochastic differential equations. *Real and Stochastic Analysis*, , CRC Press, Boca Raton, FL, (1997), 225-302.
- [104] Nonlinear prediction with increasing loss. J. N. Srivastava: felicitation volume. *J. Combin. Inform. System Sci.* 23 (1998), no. 1-4, 187-192.
- [105] Characterizing covariances and means of harmonizable processes. *Infinite Dimensional Analysis and Quantum Probability*, Kyoto (2000), 363-381.
- [106] Multidimensional Orlicz space interpolation with changing measures. *Peetre 65 Proceedings*, Lund, Sweden, (2000).
- [107] Representations of conditional means. Dedicated to Professor Nicholas Vakhania on the occasion of his 70th birthday. *Georgian Math. J.* 8 (2001), no. 2, 363-376.
- [108] Convolutions of vector fields. II. Random walk models. *Proceedings of the Third World Congress of Nonlinear Analysts, Part 6 (Catania, 2000)*. *Nonlinear Anal.* 47 (2001), no. 6, 3599-3615.
- [109] Martingales and some applications. Shanbhag, D. N. (ed.) et al., *Stochastic processes: Theory and methods*. Amsterdam: North-Holland/Elsevier. *Handbook Statistics* 19,(2001) 765-816.
- [110] Probability (revised and expanded for 3rd ed.), *Encyclopedia of Physical Science and Technology* (2002), pp. 87-109.
- [111] Representation and estimation for harmonizable type processes. *IEEE*, (2002) 1559-1564.
- [112] A commentary on "Une Théorie Unifiée des martingales et des moyennes ergodiques", *C.R. Acad. Sci* 252 (1961) p. 2064-2066, in *Rota's Saleta*, Birkhauser Boston (2002)
- [113] Evolution operators in stochastic processes and inference. *Evolution Equation*, G. R. Goldstein, R. Nagel, S. Romanelli, editors, Marcel Dekker Inc. (2003), 357-372.
- [114] Stochastic analysis and function spaces. *Recent Advances in Stochastic Processes and Functional Analysis*, A.C. Krinik, R.J. Swift, editors, Marcel Dekker Inc. (2004), 1-25.

Books Edited

- [1] General Topology and Modern Analysis. Proceedings of the F.B. Jones Conference, Academic Press, Inc., New York (1981), 514 pages, (Edited jointly with L.F. McCauley).
- [2] Handbook in Statistics, Volume 5, Time Series in the Time Domain, (Edited jointly with E.J. Hannan, P.R. Krishnaiah), North-Holland Publishing Co., Amsterdam (1985).
- [3] Real and Stochastic Analysis, (Editor), Wiley & Sons, New York (1986), 347 pages.
- [4] Multivariate Statistics and Probability, (Edited jointly with C.R. Rao), Academic Press Inc., Boston (1989), 565 pages.
- [5] Real and stochastic analysis. Recent advances. (Editor) Boca Raton, FL, CRC Press. (1997), 393 pages.
- [6] Real and stochastic analysis. New Perspectives. (Editor) Birkhauser Boston (in preparation).

Books Written

- [1] Stochastic Processes and Integration. Sijthoff & Noordhoff International Publishers, Alpehn aan den Rijn, The Netherlands, (1979), 460 pages.
- [2] Foundations of Stochastic Analysis, Academic Press, Inc., New York, (1981), 295 pages.
- [3] Probability Theory with Applications, Academic Press, Inc. New York, (1984), 495 pages.
- [4] Measure Theory and Integration, Wiley-Interscience, New York (1987), 540 pages.
- [5] Theory of Orlicz Spaces (jointly with Z. D. Ren), Marcel Dekker Inc., New York (1991), 449 pages.
- [6] Conditional Measures and Applications, Marcel Dekker Inc., New York (1993), 417 pages.
- [7] Stochastic Processes: General Theory, Kluwer Academic Publishers, The Netherlands (1995), 620 pages.
- [8] Stochastic Processes: Inference Theory, Kluwer Academic Publishers, The Netherlands (2000), 645 pages.
- [9] Applications of Orlicz Spaces (jointly with Z. D. Ren), Marcel Dekker Inc., New York (2002), 464 pages.
- [10] Measure Theory and Integration, (Revised and enlarged second edition), Marcel Dekker Inc., New York (to appear, 2004).
- [11] Probability Theory with Applications, (jointly with R. J. Swift), (Revised and enlarged second edition), Kluwer Academic Publishers, The Netherlands (in preparation).

[12] Conditional Measures and Applications, (Revised second edition), Marcel Dekker Inc., New York (in preparation).

Ph.D. Theses Completed Under the Direction of M.M. Rao

At Carnegie-Mellon University:

Dietmar R. Borchers (1964), "Second order stochastic differential equations and related Ito processes."

J. Jerry Uhl, Jr (1966), "Orlicz spaces of additive set functions and set martingales."

Jerome A. Goldstein (1967), "Stochastic differential equations and nonlinear semi-groups."

Neil E. Gretskey (1967), "Representation theorems on Banach function spaces."

William T. Kraynek (1968), "Interpolation of sub-linear operators on generalized Orlicz and Hardy spaces."

Robert L. Rosenberg (1968), "Compactness in Orlicz spaces based on sets of probability measures."

George Y. H. Chi (1969), "Nonlinear prediction and multiplicity of generalized random processes."

At University of California, Riverside:

Vera Darlean Briggs (1973), "Densities for infinitely divisible processes."

Stephen V. Noltie (1975), "Integral representations of chains and vector measures."

Theodore R. Hillmann (1977), "Besicovitch - Orlicz spaces of almost periodic functions."

Michael D. Brennan (1978), "Planar semi-martingales and stochastic integrals."

James P. Kelsh (1978), "Linear analysis of harmonizable time series."

Alan C. Krinik (1978), "Stroock - Varadhan theory of diffusion in a Hilbert space and likelihood ratios."

Derek K. Chang (1983), "Bimeasures, harmonizable process and filtering."

Marc H. Mehlman (1990), "Moving average representation and prediction for multidimensional strongly harmonizable process."

Randall J. Swift (1992), "Structural and sample path analysis of harmonizable random fields."

Michael L. Green (1995), "Multi-parameter semi-martingale integrals and boundedness principles."

Heroe Soedjak (1996), "Estimation problems for harmonizable random processes and fields."