J. Indian Inst. Sci., 66, Apr. 1986, pp.293–306.

BOOK REVIEWS

Dilation theory, Toeplitz operators and related topics, 7th International Conference on Operator Theory, Timişoara and Herculane (Romania), 1982, Volume 11 in Operator Theory: Advances and applications, edited by C. Apostol, C. M. Pearcy, B. Sz.-Nagy, and D. Voiculescu, Birkhäuser Verlag, Basel, 1983, pp. 408, S. Fr. 74. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

The present volume consists of 24 carefully selected papers by specialists working in various areas of operator theory. The proceedings of such conferences is beneficial not only to the experts who participate, but a coherent presentation of this kind can stimulate thought among several other researchers and students working in operator theory.

There is virtually no branch of mathematics with which operator theory is not making contact and hence it serves the purpose of unification of mathematics in some sense. Techniques in Banach, function, C^*, W^*, Von-Neumann and homological algebras are used in operator theory.

Although dilation theory and Toeplitz operators form the main theme of this volume, as is clear from the fact that majority of the contributed papers are in these areas, such 'other topics' as Atiyah–Singer theorem for pseudo-differential operators on vector bundles over compact G-manifolds, trigonometric moment problem, Schrödinger operators, interpolation problems, Seagull construction of I. D. Berg, 'measures of size' for Hilbert space operators, dynamical systems, Markov processes, Sheaf theoretic models, local and global analytical functional calculus, the idea of ext-group also make their appearance. This definitely gives an idea of the vast 'spectrum' covered under the banner of operator theory and also makes one aware of his own limitations within the confines of operator theory.

Using the concept of Kozul complex in spectral and Fredholm theory, E. Albrecht and F. H. Vasilescu discuss the problem of upper semicontinuity of various spectra and survey stability under small perturbation and invariance with reference to duality. For ordered locally convex spaces, Alpay discusses the question of when $L(E, F)$ is a vector lattice and considers the question of positive generation of operator ideals.

Z. Ceauşescu and I. Suciu, after sketching known constructions of Ando-dilations, use the notions of 'choice sequences', adequate isometry and generating sequences to label all Ando-dilations. The paper of K. Clancey focusses on Toeplitz models for operators having rank-one self-commutator. His model is a refinement of dilation model of Sz.-Nagy and Foias for hyponormal operators.

L. A. Coburn defines and examines the exact relationship between equivalent index and representation theory of compact groups. Applying his results to Toeplitz operators on H^2 of a torus he obtains a new phenomenon which can be compared with

Atiyah–Singer index theorem for pseudo-differential operators. T. Constantinescu utilises the idea of trigonometric moment problem and obtains an algorithm which associates, with a positive operator-valued Toeplitz form, a uniquely determined 'choice sequence'. D. Gurarie and M. A. Kon establish a number of regularity properties of elliptic operators. Using important concepts from functional analysis, F. Helsinger obtains sharp results for the interpolation problem in certain spaces of holomorphic functions. H. Helson generalises his earlier theorem related to principle of uniform boundedness to topological vector spaces.

D. A. Herrero's significant paper is about approximating an operator with diagonal matrix by nilpotents. Several generalizations and analogues are obtained. He produces operators with continuous extensions to l^p and l^q with 'large' spectra s.t. spectra of corresponding operators on l^r $(p<r<q)$ as small as possible. By reversing an argument of I. D. Berg a normal operator can be approximated by weighted shifts. He uses the Seagull construction of I. D. Berg and Berg–Sikonia extension of Von-Neumann–Weyl theorem to prove that N is normal iff it is (norm) limit of quasinilpotents iff it is (norm) limit of nilpotents iff $\sigma(N)$ is connected and $0 \epsilon \sigma(N)$. Approximation of compact operators by finite rank nilpotents is treated. Using his main theorem (2.3), Herrero produces much more pathological type of examples than that of T. B. Hoover.

J. A. Holbrook surveys some results and open problems in terms of various 'measures of size' for Hilbert space operators. A question of Halmos has been answered for 'completely' polynomially-bounded operators. J. Janas obtains a model for n-commuting unilateral shifts and also for commuting subnormal n-variable weighted shifts. B. Kümmerer considers completely positive operators on W*-algebras. He examines general properties of dynamical systems and their dilations and presents construction schemes. N. N. Nikol'skii while dealing with Toeplitz operators considers the role of semicommutators, abelianization of Toeplitz algebras, description of commutator ideals, computation of the rank of semicommutators, etc. "Is every operator T with trace class self-commutator a compression modulo the Hilbert–Schmidt class of normal operators?" This problem which turns out to be hard even for monotone shifts is affirmatively resolved by C. Pasinescu under additional assumptions.

The aim of M. Putinar's paper is to present a sheaf theoretic model for a general commuting n-tuple of bounded operators on a Banach space. It can be used to explain a series of spectral theoretic phenomena such as local and global analytical functional calculus. J. Eschmeier deals with spectral duality theory. Among other sheaf models, his canonical model has universality property. He proves that the decomposable operators are exactly those which admit a soft Frechet–sheaf model. N-Riedel in his paper proves that Weak Dixmier Property (WDP) implies Dixmier Property (DP). Haagerup solved the problem, but the proof cited in this paper is that of L. Zsido.

N. Salinas extends the notion of I-smooth elements of ext($\mathscr{A}$), where $\mathscr{A}$ is unital, separable, C*-algebra (not necessarily abelian) and I is a separable norm ideal. His approach implies that these form a group. If $\mathscr{A}$ is nuclear then ext($\mathscr{A}$) = standard ext-group of $\mathscr{A}$. He defines Sm ext($\mathscr{A}$, S; I) and shows that this is a group, where S is a countable, I-central, subset of $\mathscr{A}$. In general it is much larger than ext($\mathscr{A}$, S; I). The notions of I-smooth joint quasitriangularity and quasidiagonality are reviewed and the notions of quasitriangular and quasidiagonal smooth extensions are introduced. K. Schmidgen presents the construction of weak intertwining operators and construction of admissible boundary spaces. The paper of J. Stochel deals with *-definite kernels b on S, an abelian *-semigroup without neutral element. He expresses b as a sum of trivial and non-trivial parts. For non-trivial *-definite kernels he proves the existence of a unique positive Radon measure with some desirable properties.

J. Stochel and F. H. Szafraniec define the concepts of bounded vectors and formally normal operators. They also give a characterization of some unbounded subnormal operators. They define normally positive definite operators (NPD). Their results are geometric in nature. B. Sz.-Nagy and C. Foias introduce and investigate a new class of T-Toeplitz operators, τ_T. They show the existence of a unique map $H \to \hat{H}$ of τ_T into the commutant of R, the unitary part of the minimal isometric dilation of T, which is one-one, onto, norm and adjoint preserving s.t. $[p(T)Hq(T^*)]^\wedge = p(R)\hat{H}q(R^*)$ for any polynomials, p, q. $\hat{H}$, the symbol of H, is normal and satisfies $\hat{H}R = R\hat{H} = H^\wedge$. They show that hyponormal operators are T^*-Toeplitz for some contraction T. Conversely it is shown that hyponormal operators can be obtained from the normal ones by these techniques. D. Timotin shows that the map ρ in Bartle–Graves theorem can be chosen s.t. it takes values in finite dimensional subspace of Y, in case d = dim $(Y/X) < \infty$

In a survey article, H. Upmeier discusses the recent progress in the theory of multivariate Toeplitz and Wiener–Hopf operators. The Toeplitz C*-algebra generated by Toeplitz operators with continuous symbols is shown to be a solvable C*-algebra. In particular, its irreducible representations are shown to be in one-one correspondence with Jordan triple idempotents.

One of the major contributions of a volume of this kind could be to bring together specialists working in various facets of operator theory and create some kind of 'awareness' of the total broad spectrum of this discipline. Although, it is impossible for a single person to be in complete command of the voluminous growth and development in this area, this volume will undoubtedly serve the purpose of acquainting people of the 'culture' to which they belong. Obviously the details of proofs of the theorems presented in such a volume are too technical and the machinery used is pretty heavy to be within the reach of a single person.

The book is well-organised, well-planned and amply demonstrates the importance of the present state of rapid developments in operator theory and its applications. At any rate it is certainly a valuable reference book for researchers in operator theory. For potential readers it will stimulate thought regarding the beautiful and breathtaking account of happenings in the rich area of operator theory.

Department of Mathematics — ARUN D. JOSHI
University of Poona
Pune 411 007.

Spectral theory of linear operators and related topics (Proceedings of 8th International Conference on Operator Theory, Timisoara and Herculane (Romania), 1983, Volume 14 in Operator Theory: Advances and applications) edited by H. Helson, B. Sz.-Nagy,

F. H. Vasilescu and D. Voiculescu. Birkhauser Verlag, Basel, 1983, pp. 306, S. Fr. 68. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

The book reflects a variety of problems and techniques of modern operator theory which includes topics such as: (a) dilation theory (b) operators on indefinite metric Hilbert spaces, (c) invariant subspaces, (d) operator algebras (e) operators with generalized spectral decompositions and other topics.

Given below is a brief review of the papers appearing in this volume:

E. Albrecht in his article on spectral interpolation considers the spectral behaviour of n-tuples of commuting bounded linear operators on interpolation spaces. He obtains generalizations and improvements of results for the case of single linear operators. The joint spectrum has been shown to be upper semicontinuous w.r.t. interpolation parameter θ. Stability properties of the Fredholm behaviour w.r.t. small change of θ are considered. V. Bartik, K. John and J. Korbas consider tensor products of operators and Horn's inequality; an elementary proof given may be useful for other generalizations. Z. Ceauşescu and I. Suciu present some results concerning minimal unitary extension of an Ando-dilation (produced by the Sz.-Nagy–Foias construction).

Recently, the phenomenon of 'blowing up' of the spectrum has regained interest, especially in connection with the Scott-Brown technique. B. Chevreau and J. Esterle *via* the Banach algebra approach and using ideas of multipliers, bounded approximate identity, peak sets, uniform algebras consider spectral properties of subalgebras of H^∞ (D) containing the disc algebra. T. Constantinescu presents an operatorial version of the Carathéodory-Fejer problem with an algorithm which connects a contractive intertwining dilation with its choice sequence. For $\phi \in H^\infty$, M_ϕ is an analytic Toeplitz operator. We get, *via* functional calculus, $M_\phi = \phi(S)$ where S is the unilateral shift on H^2. Those $\phi \in H^\infty$ for which Lat $S = \text{Lat}\,\phi(S)$ are studied in J. Dazord's article.

J. Eschmeier shows that there exists a reasonable duality theory for finite commuting systems of operators on Banach spaces.

In continuation to Wold decomposition of isometry and the Sz.-Nagy–Foias theory of contractive and isometric representations of Z_+, I. Suciu considers a subsemigroup S of an abelian group G. The author gets a 'strange' part in addition to the unitary and translation part. The right evanescent part of H. Helson and D. Lowdenslager's work corresponds to this 'strange' part. G. Gaşpar and N. Suciu present another decomposition of the isometric semigroups which in a certain sense is dual to that of I. Suciu. A. Gheondea gives a coherent treatment of the pseudoregular subspaces from a geometric point of view. Pseudoregularity is recognised as fruitful since it permits generalisations of facts from Pontryagin spaces to general Krein spaces. G. Heinig and B. Silbermann 'extend' the 'classical' theory of factorization in algebras of continuous functions to factorization in algebras of bounded functions on a closed smooth contour.

P. Jonas considers definitizable J-selfadjoint operators, criterion for regularity of a critical point in terms of uniform boundedness of a certain set of operators. Sufficient conditions for preservation of regularity of a critical point under finite rank perturbations of the resolvent are obtained. H. Neidhardt develops a scattering theory for maximal dissipative operators. The existence and 'completeness' of wave operators is also treated. V. V. Peller considers Nuclear Hankel operators acting from H^p to H^q and formulates an analogue of Nehari's theorem in this case. A von-Neumann algebra $\mathcal{M}$ is said to have (JP) property if Johnson–Parrott theorem holds for $\mathcal{M}$. The study of type II_1 factor becomes important. If $\mathcal{M}$ is a type II_1 factor that has a Cartan subalgebra or splits such a factor, then $\mathcal{M}$ has (JP). S. Popa introduces property (c) which is weaker than Γ of Murray and von-Neumann. It is stable under tensor products and holds for factors with Cartan subalgebras. He proves that $(c) \Rightarrow$ JP)

The Johnson-Putnam theorem was extended by Stampfli, Radjabalipour and Clancey to the case of hyponormal ones and by Vrbova to the class of generalized scalar operators (defined by Foias). The mere existence of local inverses for generalized scalar or spectral operators does not imply the existence of local resolvents. Some extra differentiability on the local inverse are required. For spectral operators, Fong and Radjabalipour did it by mere boundedness of g_x. However, there was a gap. In this article, Radjabalipour shows that in a reflexive Banach space, in which Johnson–Putnam result is true for every scalar-type spectral operator, every bounded local inverse can be replaced by local resolvent. D. M. Saina presents an article on 'operators with strongly closed range'.

The harmonic analysis of the group algebra acting on the $C*$–algebra *via* the action of the group of automorphisms has been much studied. A. M. Sinclair presents in his article a version of Grothendieck's inequality (and Linderstrass–Pełczyn'ski matrix version of the same. This paper is intended as an introduction to some of the problems on closed subalgebra of $B(B(H))$. He also discusses some ideas and problems on the unital Banach algebra generated by a$*$–derivation on $\mathcal{B}(H)$ and its relation to the projective tensor product and ideas in numerical range. Bicontinuous representations of group algebras are discussed in the final section. J. Stochel discusses positive definite (PD) forms and weakly-positive forms (WPD)in his paper. He introduces the bounded condition (BC). The purpose of this paper is to extend his own earlier results from abelian$*$–semigroups to the non-abelian case. Locally convex spaces having strong factorization property (which contain all barelled spaces and Banach spaces) are considered. A new version of Sz.-Nagy's general dilation theorem is formulated. Sufficient conditions for subnormal to be bounded are given. J. Stochel and F. H. Szafraniec present a different version of a theorem of T. T. Trent on subnormality. Their version makes it possible to consider other possible generalizations (*e.g.* subnormal systems of operators where Trent's proof breaks down) and the case of unbounded operators.

F. H. Vasilescu deals with homogeneous liftings and projections for their applications in the geometry of Banach spaces. Duality mappings play an important role in non-linear analysis. He defines approximate duality mappings. He also defines homogeneous operators and considers the Banach space $H(X, Y)$ of bounded-homogeneous operators. Spectral theory for these is a difficult task. Some stability results are proved. He then considers $KH(X, Y)$–compact homogeneous operators from X to Y. The behaviour of compact homogeneous operators is different from that of compact linear operators; an example is presented. This somewhat disappointing example points out that a Fredholm theory in $H(X, Y)$ is a difficult matter. Perhaps the space $H(X, Y)$ is 'too large'. There is a hope that if one replaces the algebraic dimension by a topological one such a theory could be constructed. H. Widom studies, for a pseudodifferential operator A of negative order in $\mathbb{R}^n$, two cases of interest: (a) A having a specific amplitude function, (b) classical positive elliptic operator of negative order—r. The nature of formal expansion for $tr\, f(P_\Omega A P_\Omega)$ (f a 'suitable' function) and in general terms how it is derived is discussed here (The proofs of these results will be given elsewhere).

Finally, the definition for an operator $T \in B(H)$ to have property L is given in M. Zajac's paper. If H is finite-dimensional all $T \in \mathscr{B}(H)$ have property L. In the general case normal and unitary operators have property L (*via* Fuglede–Putnam theorem). Wu has proved that a c.n.u. contraction with finite defect indices has property L if (a) $T \in C_0$ or (b) $T \in C_{11}$ or (c) T is a weak contraction. He has earlier proved that every c.n.u. weak contraction has property L. In this paper a new proof is given and quasisimilarity invariance of Hyplat (T) for these is obtained.

An interesting feature of the book is a big list of open research problems in operator theory. These were discussed among the participants of the conference. There are more than 20 problems, and many are as yet unsolved. Partial answers to some of these are known. Thus, the book provides the reader with a wealth of information on operator theory, operator algebras, dilation theory and makes him start thinking about the unlimited scope he has (whether he is a beginner or an established mathematician). Any reader with training in basic functional analysis and operator theory (such as the book of P. R. Halmos' *Hilbert space problem book*) will be benefitted by reading this book. The amount of assimilation will vary from reader to reader depending on his depth of interest in the subject.

Department of Mathematics
University of Poona
Pune 411 007.

ARUN D. JOSHI

Elements of logic and foundations of mathematics in problems by Wiktor Marek and Janusz Onyszkiewiez. D. Reidel Publishing Company, Dordrecht, Holland, 1982, pp. viii + 276, D. Fl. 90.

The work of George Cantor on set theory, arising out of investigations in the foundations of mathematical analysis, is considered as a breakthrough on a scale unknown since the calculus of Leibnitz and Newton. Subsequently, set theory has passed on from naive to very axiomatic studies culminating in the very fundamental works of Goddel and Cohen in the foundations of mathematics.

Particularly with the enormous interest in recent years in computer science and the relevance of logic and set theory in this subject, these subjects have become a basic core for all computer scientists in particular and a variety of applied mathematicians in general, besides being a subject of main interest for the purists.

The book under review makes an attempt to introduce the reader to the main ideas of these subjects through a large collection of well organized problems guided by hints for solving these. It will be found to be a useful source of problems by the teacher as well as the student. Though the author claims that it is ideally suited for independent individual study and that it can also be used as supplementary reading for courses in set theory and elementary logic, this reviewer is of the opinion that it is more suited for the latter purpose.

There are 13 chapters and two supplements, one on 'Induction' and the other on 'Lattices and Boolean algebras'. The first eight chapters contain problems respectively on propositional calculus, algebra of sets, propositional functions–quantifiers, relations–equivalences, function-generalized set theoretical operations, cardinal numbers and orderings. The 9th chapter is intended as a review of the first eight chapters and contains problems the solutions of which involve one or more ideas introduced in the first eight chapters. The solutions to the problems on chapter 9 are, we believe, intentionally not given with a view to avoid the temptation to look at the solutions but to work out for oneself so as to get a self-test of the level of understanding of the first eight chapters. Chapters 10 to 13 contain problems respectively on cardinal and ordinal arithmetic, formal systems and their properties, model theory and recursive functions, followed by the two supplementary sections containing problems on induction, lattices and Boolean algebras. At the end of the two supplements the hints to solutions of the problems are given chapterwise (except for the problems in chapter 9 – as already mentioned above). At the beginning of each chapter the basic terminologies are very quickly introduced before stating the problems. The book ends with a very brief reference of books on set theory, logic and Boolean algebras.

There are quite a selection of easy problems in each chapter for the routine drill, but there are also enough problems that follow these that makes one think and get the ideas cleared. As one who teaches core mathematics regularly for graduate students in computer science, this reviewer does propose to draw freely from the problems of this book for class-room discussions and for assignments for the students.

Department of Applied Mathematics — R. VITTAL RAO
Indian Institute of Science
Bangalore 560 012.

Matrices and indefinite scalar products (Vol. 8 in Operator theory: Advances and applications) by I. Gohberg, P. Lancaster and L. Rodman; edited by I. Gohberg. Birkhauser Verlag, CH-4010 Basel, 1983, pp. xvii + 374, S. Fr. 70. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

This volume gives a very lucid account of the theory and application of matrices in the presence of an indefinite scalar product. It is a fine introduction leading the reader to the active research area of indefinite scalar products and related operators which has been an active field of research for about a quarter of a century now. The volume is self-contained, the style is excellent and very clear and is a must for any researcher in operator theory.

The volume is divided into four parts. The first part deals with the general theory of operators in finite dimensional spaces, their canonical forms and some related questions of functional calculus. This is parallel to the classical theory of self-adjoint or unitary matrices but now the classical inner product being replaced by indefinite inner product.

The second part of the book deals with four applications. They are: (1) Hamiltonian and self-adjoint differential equations with periodic equations with special reference to the close relationship between the periodic coefficients and the matrizant; (2) Hermitian matrix polynomials and their factorization with applications to difference and differential equations; (3) an account of Hermitian rational matrix functions with special reference to the problem of factorization and (4) symmetric matrix algebraic Riccati equation with emphasis on the role of M-invariant subspaces in the description of the solutions. The four chapters of the second part can be read independent of each other.

The third part is a natural sequel to the first two parts. There are two main goals in this part. The first is to further extend the theory developed in the first part to questions relating to perturbations and stability of H-self-adjoint and H-unitary matrices. The second is to apply this extended theory to the problems of the second part.

The first chapter of the fourth part is the final aspect in continuation of the general theory developed in the first part about matrices in the presence of indefinite scalar product. The fourth part then goes on to apply these final aspects (i) to the study of the connected components of differential and difference equations with constant Hermitian coefficients and stably-bounded solutions, and (ii) to a treatment of the well-known results of Gelfand, Lidsku, Coppel and Howe concerning the connected components of linear Hamiltonian systems with periodic coefficients and stably-bounded solutions.

This volume will give an excellent introduction to a variety of active research problems in operator theory and applications and is strongly recommended for all those interested in operator theory.

Department of Applied Mathematics R. VITTAL RAO
Indian Institute of Science
Bangalore 560 012.

Anniversary volume on approximation theory and functional analysis (International Series on Numerical Mathematics, No. 65) edited by P. L. Butzer, R. L. Stens and B. Sz.-Nagy. Birkhäuser Verlag, Basel, Switzerland, 1984, pp. 635, S. Fr. 88.

This volume consists of lectures given at the International Conference on Approximation Theory and Functional Analysis held at Oberwolfach in July–August 1983. It commemorates at the same time the 70th anniversary in 1983 of the birth of Professors L. Iliev (Sofia), R. Philipps (Stanford), B. Sz.-Nagy (Szeged) and A. C. Zaanen (Leiden) as well as the 20th anniversary of the first Oberwolfach conference on Approximation Theory held in August 1963.

The volume contains 45 papers on a broad spectrum of topics in approximation theory and functional analysis. In addition, it contains an article devoted to new and unsolved problems in the area as well as four biographical articles devoted to the personality of the scholars to whom the proceedings are dedicated.

The papers contained can be broadly classified under four major headings: approximation theory, harmonic analysis, functional analysis, and operator theory. The topics covered under approximation theory include abstract approximation in which the concern is with the comparison of approximation processes, the gliding hump method, certain interpolation spaces, and n-widths, approximation of functions of one or two real variables by linear approximation processes or with best approximation of those functions by polynomials, also on disjoint intervals, approximation of functions of complex variables, including the Shannon sampling theory, classical interpolation problems, orthogonal polynomials and functions, abstract harmonic analysis and their applications, approximation of solutions of ordinary and partial differential equations. Under operator theory, the topics covered treat certain classes of operators such as contraction, hyponormal and accretive operators, as well as the suboperators and semigroups of operators. The papers under the heading of functional analysis dwell on function spaces, algebras, ideals, and generalized functions.

The organization of material in this volume is excellent. There is a wealth of survey articles that not only describe fundamental advances in their subfields, but also bring out basic interconnections between the various research areas. On the whole, this volume will serve as a valuable source of reference to research workers in the area. Its timely appearance will also enhance further interest and interaction in the domain.

Deparment of Mathematics — D. V. PAI
Indian Institute of Technology
Powai, Bombay 400 076.

George Polya, Collected papers, Vol. III edited by J. Hersch and G. C. Rota. The MIT Press, Cambridge, Mass., 1984, $ 57.50.

Volume IV of this series (the final one) has already been reviewed in an earlier issue (**65** B, Nov. 1984, 327–8). The format of Volume III is similar. It contains Polya's papers on analysis and mathematical physics, spanning the years 1913 to 1976, there being 58 papers in this collection. On pp. 485–528 of this volume are annotations by specialists in various areas of the scope of several of these papers and descriptions of related later work by others; these form an invaluable source of guidance to the widely ramified work of Polya. To give a sample of the material covered (drawing freely on these annotations in the process):

One of these papers deals with an algorithm to obtain the best l_∞ ('Tchebycheff') approximation to a continuous function. One, dealing with an integral equation considered by C. Runge ($\phi * \phi = f$, f given and ϕ to be solved for; $*$ stands for convolution), foreshadows the Wiener–Tauberian theorem and the Paley–Wiener theorem. A couple of papers concern the representation of Riemann integrals as limits and asymptotic formulas of number theory. Two others consider the size of the largest prime factor of certain polynomials — work that has been followed up by others, esp. J. Coates. One deals with the distribution of quadratic residues and non-residues, work inter-related with that of Landau in the area. A paper of miscellaneous remarks on number theory contains a conjecture of Polya's that, for each $x \geq 2$, there are at least as many integers $\leq x$ having an odd number of prime factors as there are with an even number of prime factors — finally settled negatively after forty years by Haselgrove in 1958; related conjectures (one contradicting the other) due to Mertens and to Good and Churchhouse are to be found in the 'Comments'. One deals with a mean value theorem (MVT) for functions of several variables, and one with an MVT corresponding to a given linear homogeneous differential equation (with the 'disconjugacy' of such an equation).

One studies matrix solutions of the Cauchy functional equation and one with spline interpolation problems, introducing inequalities now called the Polya conditions. One deals with convergence of quadrature formulas; one particular result herein occupies a place of importance in quadrature theory. There are several papers devoted to mathematical physics (on estimating electrostatic capacity, isoperimetric problems of various kinds — vide also the book on the latter subject by Polya and Szego as well as pp. 497-504 of the volume under review for detailed comments on Polya's and related work).

There is no questioning the fact that this and its three companion volumes should be found in any library of mathematics. The annotations form a particularly valuable adjunct to these volumes and the editors are to be congratulated on the thorough-going nature of the job they have done.

Indian Statistical Institute
Delhi Centre
New Delhi 110 016

B. RAMACHANDRAN

Inner exile by Elisabeth Heisenberg. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1984, pp. 170 + xvii, S. Fr. 38.

This book has been written by Elisabeth Heisenberg to clear certain misunderstandings about her husband Werner Heisenberg. As is well known, Heisenberg is one of the outstanding scientists of the 20th century and is one of the founders of quantum mechanics.

But during the Nazi régime, when most of the Jewish scientists fled Germany, Heisenberg (who is not Jewish) chose to remain in Germany. But in his public utterances, he gave support and spoke favourably of Jewish scientists and was against persecution. Therefore, he was branded as a friend of Jews by Germans. However, the fact that he remained inside Germany during the war period and was associated with the atomic energy programme of Germany made people think that he was pro-establishment during the Nazi period. All these suppositions are not true and the book is an effort to clear the misunderstanding. Being his wife, Elisabeth Heisenberg is the best person to project the mind of her husband. She has done a splendid job. The book deals with the childhood and youth of Heisenberg and it brings out beautifully how Heisenberg achieved what he actually did. If he took up any challenge, he will put his heart and soul in the matter and see that he succeeds in his efforts. His association with Prof. Niels Bohr which ultimately led to the creation of quantum mechanics is beautifully described. Yet it is tragic that the relationship between Heisenberg and Bohr was estranged for sometime, because Heisenberg continued to stay in Germany. Heisenberg stayed in Germany not because he liked the regime but his love of German culture and language was enormously great. He could not live anywhere else. Furthermore he studied that by staying in Germany he could work for the cause of some scientists who would otherwise have been persecuted. The book describes the end of the war, imprisonment of Heisenberg and dropping of the atomic bomb on Japan. It shows how deeply Heisenberg and Otto Hahn were disturbed on the dropping of the bomb. In fact, there was a fear that Hahn, the discoverer of fission, may commit suicide. After the war, Heisenberg wanted to build science in Germany afresh. He commanded great respect and the post-war leaders of Germany trusted in his leadership. He continued to play an important role by helping young talents to come up and also do his own researches. His collaboration with Prof. Pauli on unified field theory eventually led to parting of ways.

Heisenberg wanted to help scientists of developing countries also and he was instrumental in the creation of Alexander von Humboldt Foundation through which the scientists of various countries could visit Germany and German scientists could also visit other countries. Thus his dream of one family of scientists of the whole world was partially satisfied. Elisabeth Heisenberg has really succeeded in removing serious misunderstandings and has brought to light many factors which would have remained unknown to public at large. This is an extremely valuable book and I recommend it strongly for all libraries and to persons who would like to buy a personal copy. The book has a large number of beautiful photographs concerning the life of Heisenberg.

Centre for Theoretical Studies K. P. SINHA
Indian Institute of Science
Bangalore 560 012.

The evolution of programs by Nachum Dershowitz. Birkhauser–Verlag AG, P. O. Box 133, CH-4010 Basel, Switzerland, 1983, pp. 357, S. Fr. 64.

This book is about program construction in general and about evolutionary aspects of programming in particular. Based on the author's Ph.D. thesis, it discusses several aids for semi-automatic program construction, such as annotation, debugging, modification, abstraction, instantiation and synthesis.

The author begins the book with a general overview of the approach, providing the reader a glimpse of the various techniques with the help of a lucid, well-explained example. The next chapter (chapter 3) discusses 'global' transformations on a program which may be used to derive another program from a given program. Any analogy existing in the input-output specifications of the two programs is used to suggest a transformation. This technique is also used to suggest how an incorrect program may be debugged to obtain a correct program. Analogy is used again in chapter 4 to obtain an abstract scheme of a set of programs, which may in turn be used to obtain new programs through the process of instantiation.

The ambitious task of program synthesis is the topic of chapter 5. The author explains how the initial goal may be divided into subgoals in synthesizing a program using several examples. Extending a program to achieve additional tasks is also considered. Annotating a program, with invariants, which is discussed in chapter 6 is necessary for debugging and documentation purposes and perhaps would be one of the most useful features when incorporated in a programming system. The various rules for annotating a program are explained with the help of examples. The last chapter is devoted to general discussions in which the author describes how the techniques discussed in the book may be incorporated in a semi-automatic programming system.

All the chapters first provide an overview of the technique followed by several examples. The examples have been explained in great detail so that reading through the book is not too strenuous. However, the reader should be cautioned that the book requires careful reading to get a good understanding of the techniques. It does not require any special prerequisites — only some working knowledge of predicate logic and familiarity with the use of invariants in programs. It is very well written and is definitely recommended to anybody seriously interested in automated programming.

Department of Computer Science and Automation
Indian Institute of Science
Bangalore 560 012.

Y. N. Srikant

Fundamentals of optical fibre communications edited by Michael K. Barnoski. Academic Press, Inc., 111 Fifth Avenue, New York, N. Y. 10003, 1981, 2nd edition, pp. vii + 351, $ 22.

Communications is an integral area of acquisition, transmission, processing and storage (ATPS), of information and during the past two decades more and more of the ATPS endeavours are being accomplished by using light beams (or photon streams) as information carriers. The advantages that photons offer over electrons as information carriers are the main reason for this great spurt in what has come to be known as optical (or photonic) communications. In any communication link a vital item is the so-called channel or the transmission medium. Free space has served well for decades as a channel, especially at electrical frequencies, and in the context of light, optical fibres are rated to be the best channel elements. The technologies of making, as well as utilising optical fibres, have grown exponentially during the past two decades and now it is almost certain that the future of communications lies more with photons than electrons.

The book under review belongs to the field of optical fibre-based information transmission, which is a rapidly growing field in the total area of optical communications. In a rapidly evolving field such as this, there exists the need for a book which is concerned with hard core concepts. To a great extent Barnoski's book meets this requirement. It is heartening to see the second edition of this book, which first appeared in 1976. Since 1976 many books have appeared on this subject; still Barnoski's book continues to attract the attention of scientists/engineers engaged in research and teaching in the field of fibre optic communications.

The second edition is fatter by almost a hundred pages and the chapter organisation is much more appealing than the first edition. New information, references and problems, have added to the richness of this edition. Of course, the book is not devoid of its share of blemishes. For example, the use of circular brackets to represent both equations as well as references is confusing. Also, some sentences such as the one on p. 27 which reads "... one can use the WKBJ method, which is well-known from quantum mechanics Merzbacker (1.20)" is confusingly incomplete.

The get-up of the book is a testimony to the well-known high standards maintained by the Academic Press.

The book is both a text and a reference volume and as such it should be useful to both research scientists as well as teachers and students.

Optical Communications Laboratories S. V. PAPPU
Department of Electrical Communication Engineering
Indian Institute of Science
Bangalore 560 012.

Distributed computing systems (Synchronization, control and communication) edited by Y. Paker and J.-P. Verjus. Academic Press, Orlando, Florida 32887, USA, 1983, pp.305, $ 29.50.

This book consists of 13 articles presented at the international serminar held at the Polytechnic of Central London (PCL), London, U.K. in September 1982. It is aimed at both researchers and practitioners. The area of distributed computers has attracted considerable attention during the last eight years with the advent of powerful and inexpensive microcomputers. Large research groups in many countries are engaged in this area. The book includes articles from many research groups working in France, U.K. and U.S.A. and reflects the state-of-the-art as it existed in 1982. The editors hope that the book will serve a useful purpose in the understanding of distributed computer systems and the underlying parallelism.

Three broad areas are covered by the articles. The first part consists of seven articles on expression, specification and analysis of synchronization of distributed processes. The second part has three articles on programming languages for distributed processes. The third part consists of three articles on local area networks and distributed systems.

We quote from the preface of the book a short description of the articles in the book.

"In the first paper, J.-P. Verjus introduces the concept of synchronization between concurrent or co-operating processes by means of a resource allocation example. This illustrates the three different approaches to solving the distributed synchronization problem by distributing, splitting or duplicating state variables. The next paper by L. Sha *et al* introduces a new relational model of data consistency to deal with operating system situations where the serialization model is not always applicable. This is done in the context of the Archons project global operating system replicated at separate nodes of a loosely coupled multi-computer. D. Herman treats the control of synchronization by first using a high level language which is independent of location of processes. This then leads to the installation of a local process controller at each site which co-operates by managing approximate representation of the state of the system. The paper of O. S. F. Carvalho and G. Roucairol follows a similar line and introduces a systematic mechanism localized at each node to define protocols that ensure correctness of distributed algorithms. C. Morgan introduces a formal specification language using mainly the mathematical set theory notation. A communication system is presented as a vehicle to introduce the language formalism and the notation. P. Lauer presents a conceptual apparatus called COSY to formulate the analysis of those aspects of systems arising from their concurrency and yet capable of being readily translated into practical terms. The text is written using a new construct called 'dossier' which also includes its own definition. J.-P. Banatre's paper is concerned with the presentation of some co-operation schemes and of their use in the construction of parallel programs.

In the second part S. Abramsky and R. Bornat's paper presents a dialect of Pascal, called Pascal-m, designed to facilitate type-secure programming of systems of communicating processes, based on mailboxes. R. Campbell's paper describes another extension to Pascal where the previously introduced path expressions are extended by features for distributed programming. MASCOT described by K. Jackson is a formalism based on network diagrams used to express software structure of a real-time parallel processing system. This leads to the extended Pascal notation PACE.

In the last part the CHORUS project described by J.-S. Banino introduces the concept of 'actors' for message passing to support execution of distributed applications. A local area network designed for real-time industrial applications is described in the paper of M. Dang, G. Mazare and G. Michel. The final paper converts the MICROSS system used for interactive graphic modelling and performance evaluation of distributed computer structures developed by Y. Paker, M. Bozyigit and H. English."

This collection of articles even though somewhat dated still have valuable information which would be useful to research workers in distributed computing.

Computer Centre
Indian Institute of Science
Bangalore 560 012.

V. RAJARAMAN

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