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Book Reviews

Control theory: A guided tour by J. R. Leigh, Peter Peregrinus Ltd, Michael Faraday House, Six Hills Way, Stevenage, Herts, SG1 2AY, UK, 1992, pp. 180, £18.

This is an unusual book. It is not a 'popular' book for laymen, not a text, nor a monograph or a treatise. The closest description of what it is is indeed captured by its title: a guided tour. A glimpse at its contents will make this point clear.

The book opens with a couple of motivational chapters introducing the broad features of control theory (such as the concept of feedback) in nonmathematical terms. Having done so, it rapidly goes through the whole gamut of what would constitute one or two standard undergraduate courses. This includes further study of feedback control, the use of Laplace transform in control, transfer functions and general-frequency response methods for control system design. This is followed by a chapter on mathematical modelling, a large part of which considers statistical techniques of model fitting. Subsequent chapters deal with tests for stability, stability margins, disturbance rejection by feedback, linearization and linear control systems in state space formulation, discrete control—essentially what would constitute a good follow up course in control. But the book does not end here. It has four more chapters—one on Kalman filtering, one on nonlinear systems, one on 'optimization' (a significant part of which is devoted to optimal control) and one on distributed systems. These are generally considered advanced topics and it is unusual to find them cohabitating with the aforementioned in the same slim volume.

Needless to say, having compressed several layers of control theory into a hundred and fifty pages or so, the book cannot give more than a superficial feel of each. Several topics above would merit a book-length treatment, but have been compressed into fifteen–twenty pages here. This has been achieved by touching upon only a few key concepts in each and then giving only a bare, preliminary account of these. Like a true tourist, the reader is left with only a bunch of snapshots in hand at the end of the tour.

In the introduction, the author lists the target audience as students of control theory and other subjects and working engineers, among others. The book is indeed useful for these people, but not in the conventional sense. It can serve as a useful companion or study aid to supplement other material. For a student burdened with intensive, specialized courses, it will help get a perspective of the field. For a nonspecialist or a professional not currently in touch with the subject, it can serve as an easily accessible library of ideas which can be followed up by further study in the chosen direction. Mention must be made in this respect of the annotated bibliography that appears at the end of the book.

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Computation and control II by K. Bowers and J. Lund, Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp. 377, SFr 118.

This volume is a collection of papers presented at the Second Conference on Computation and Control held in Bozeman, Montana, USA, in August 1990. It may be recalled that the proceedings of the first conference on the topic held in 1988-was published by the same publisher earlier.

The volume features 24 papers on a variety of problems in control theory, numerical analysis and interactions between the two fields. It has been realized for a long time that while control theory has surged ahead with a number of novel ideas and techniques, there is a gap between the theory and the implementation of the algorithms suggested by the theory, in spite of widespread availability of computational power. The series of conferences on computation and control is primarily meant for exposition of methods of reducing this gap. There are also some contributions to pure control theory.

The papers in this volume can be broadly classified into the following three categories: 1) Abstract control theory, 2) Numerical solutions, 3) Problems in specific applications.

It would take a great deal of space to review each paper and hence brief comments will be made on papers in each category.

There are about ten papers on control theory for general situations not directed at any particular application. For instance, Ammar and Mehrman discuss the role of the Hamiltonian eigen problem in the solution of the algebraic Riccati equation. Byrnes considers the Riccati partial differential equation and its use in constructing explicit optimal controls as feedback laws for nonlinear systems. Burnes *et al* extend the root locus methodology for a special class of distributed parameter feedback systems. De Stefano answers several questions regarding the existence of low-dimensional universally observable systems. Kappel gives a survey of approximation methods for linear quadratic regulator problems in delay systems. Kawski discusses the use of ideas from geometric theory of nonlinear systems in adaptive control. Kunisch *et al* estimate an unknown time-dependent coefficient in the one-dimensional Stefan problem. Poore and Hager prove convergence results for the application of penalty, multiplier and Newton methods to a class of nonlinear optimal control problems. Wallace and Wolf study the sharpness of observations needed on systems described by invariant evolution equations. Wang studies the decentralized pole placement problem using static local output feedback. Zhu gives an algorithm to construct a dynamic stabilizing feedback compensator for a finite-dimensional linear time invariant system.

Among the papers directed towards numerical problems, one notices the following. Dockery uses the Sinc–Galerkin method to find travelling wave and standing wave solutions to some nonlinear reaction-diffusion equations on the real line. Gustafson describes a numerical method for calculating the inverse Laplace transform using a trapezoidal sum approximation. Gustafson and Stenger study the role of Chebyshev acceleration on Sinc approximation and approximation of $|x|^{\alpha}$. Jarratt develops a numerical procedure for observability problems in distributed parameter systems based on the knowledge of eigenvalues of Sturm–Liouville differential equations. Clyde and Martin consider the error in the approximate integration of an analytic function by Gaussian quadrature method. Tran reports on numerical studies of constructing feedback solutions to linear quadratic regulator problems for retarded systems with delay in control.

The papers dealing with more specific applications are the following. Banks *et al* develop high-fidelity dynamic models for composite material structures using homogenization techniques. Burns *et al* consider the approximation of a thermoviscoelastic model of the Boltzmann type by a sequence of ordinary differential equations. Fitzpatrick discusses numerical techniques for computing optimal temperature profiles in cooling a viscoelastic sheet so that residual stresses are minimized. Ghosh and Wu consider the vision problem of identifying the motion parameters of a rigid body by observing the perspective projections on a screen. Gilliam *et al* discuss the analytical and numerical analysis of a class of inverse problems (*i.e.*, finding the input from the given output) in systems governed by partial differential equations describing heat conduction. Kojima deals with identification of microscopic flaws arising in thermal tomography using domain decomposition method. Smith and Bowers present a Sinc–Galerkin method for the numerical recovery of the stiffness and damping parameters in the state space model of a fixed Euler–Bernoulli beam which is assumed to have Kelvin–Voigt damping.

Admittedly the above classification is not strict and there could be transfers from one category to another. One common factor that can be noticed is that most of the authors are from the Departments of Mathematics of various universities and so the contributions could be regarded as the mathematicians' view of computation and control. It is interesting to note that while mathematicians have taken up such

control-theoretic problems, the interest of engineers in them appears to be considerably reduced. One wonders whether the law of diminishing returns has become applicable to research in classical approaches to control theory.

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An introduction to quantum stochastic calculus by K. R. Parthasarathy, Birkhauser Verlag, CH-4010, Basel, Switzerland, 1992, pp. 292, SFr 138. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110 017.

Probability theory and quantum mechanics have had a long symbiotic relationship, its earliest manifestation perhaps being Born's probabilistic interpretation of quantum mechanics. The biggest point of contact between the two has been the path-integral formulation of quantum mechanics due to Feynman and its subsequent 'time-complexification' *via* the Feynman–Kac formalism which opened up the possibility of using the vast machinery of stochastic analysis for quantum mechanical computations. This in turn has dictated the research trends in stochastic processes to a nontrivial extent. Though one may arguably consider this as the use of probability as a mere tool without any fundamental physical significance, there have also been efforts, by Nelson and others, to reconstruct quantum mechanics in a more fundamental way from an underlying 'stochastic mechanics'. A third arena of interaction between probability and quantum mechanics is 'quantum probability', a more recent manifestation thereof, which has undergone a rapid growth in the past decade or so, as borne out by the number of journal articles and conferences devoted to it in recent years. In contrast to the aforementioned, where the 'classical probability' *a la* Kolmogorov *et al* was being used in the service of quantum mechanics, quantum probability is a new kind of, let's say 'quantized', probability theory. Whereas functional integration and stochastic mechanics use as their cornerstone the stochastic calculus of Ito, quantum probability has its own 'quantum stochastic calculus'. The author of the book under review is among the pioneers of this field and the book very well bears a mark of this. A brief outline of the contents follows.

The first chapter deals with the mathematical foundations of quantum mechanics, underscoring its analogy with classical probability. The quantum analog of the classical 'algebra of random variables' is the algebra of observables. These observables are represented as self-adjoint operators on a Hilbert space H. Thus, random variables which are indicators of events (*i.e.*, take value 1 on the event and 0 on its complement) have their analog in projection operators. Just as a genral random variable can be obtained as a limit of linear combinations of indicator random variables, a general observable can be expressed in terms of a projection-valued spectral measure through the spectral theorem. This measure then gives an equivalent description of the observable. A third description is given by the unitary group it generates, *via* Stone's theorem. Next comes the concept of a 'state' which is a trace class operator on H with unit trace (*i.e.*, a positive self-adjoint operator whose eigenvalues sum up to one). The quantity trace (ρA) for an observable A has properties akin to mathematical expectation in probability theory and conversely, it is the only way to obtain such an object. (A precise statement of this is a theorem due to Gleason). These and related matters are studied in the first chapter, giving a self-contained background in mathematics of simple quantum systems.

If one considers instead quantum systems consisting of an indefinite number of particles, one has to work not with a single Hilbert space H but with the direct sum of n-fold tensor products of replicas of H (or symmetrized/antisymmetrized versions thereof if the particles are 'Bosons' or 'Fermions') as n varies over natural numbers. These are the 'Fock spaces'. The Euclidean group over H (consisting of unitary transformations followed by translations) has a representation in terms of operators on the Boson Fock space, called the Weyl representation. This is a rich source of observables, most notably the creation,

annihilation and conservation operators which play a key role here. These and related issues are introduced in the second chapter, which also includes a study of connections between the Weyl representation and the infinitely divisible distributions in probability theory.

The first two chapters form a prelude to the third chapter on 'quantum stochastic calculus' where it really begins. In 'classical' stochastic calculus, one has functions of random processes obeying not the rule of ordinary calculus, but those of Ito calculus which includes second-order corrections. These typically arise as follows: The increments of Brownian motion over a time interval Δt are of order $\sqrt{\Delta t}$ and thus the second-order terms in the Taylor expansion of function of a Brownian motion remain of comparable size as the first-order terms as Δt shrinks to zero. The quantum stochastic calculus for operator-valued processes exhibits similar features. These rules are derived here, paving the way for a theory of operator-valued 'quantum stochastic differential equations'. Some special instances of these are highlighted. In particular there is a section on quantum dynamical semigroups, which, to quote from the author's introduction (describes) irreversible evolutions (and) result from averaging the solutions of a Heisenberg equation in the presence of noise, strengthening the belief that irreversible evolutions are most likely to be shadows of reversible evolutions in an enlarged universe'. This is one of the five motivational pointers for quantum stochastic calculus given by the author in his introduction. I have specifically mentioned it because of its philosophical implications which are likely to interest physicists, the other four pointers being essentially for mathematicians

To say that this is an extremely well-laid out and clearly written book would be hardly surprising, since one has come to expect it from this author. Though a large 'introduction to the introduction' within the book has probably cost the author several omissions in the later part of the book (he profusely apologizes for this in the introduction), it has indeed achieved a 'right-sized first bite' for a beginner, which this book achieves admirably. A great help in this are the constant pointers to analogies with classical probability.

Another major asset of this book is its timing. It has appeared neither too late, when the subject is fossilized, nor too soon, *i.e.*, before the pieces have begun to fall in place. It simultaneously exhibits consolidation of ideas and an air of freshness, indicative of a subject that has arrived, but only just so. As such, it will be a great boon to a young researcher getting into this field, particularly since it is the only one of its kind. (The only other exposition of the subject that I am aware of is a set of lecture notes in French by Prof. P. A. Meyer). Finally, even a student not interested in quantum stochastic calculus *per se* will find in the first two chapters a very lucid overview of the mathematics of quantum mechanics.

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The Grothendieck Festschrift (three volumes), Progress in Mathematics (PM 86, 87, 88) edited by P. Cartier, L. Illusie, N. M. Katz, G. Laumon, Y. Manin and K.A. Ribet, Birkhauser Verlag AG, Klosterberg, 23, CH-4010, Basel, Switzerland, 1990, pp. I–501/II–497/III–564, SF 318.

These three excellent volumes running to about 1500 pages contain 35 research papers of the highest quality and great current interest. The articles are contributed by 52 mathematicians of repute from all over the world. This three-volume set is a small token of appreciation and tribute to the legendary Professor Alexander Grothendieck, one of the world's greatest living mathematicians. It is a superb addition to the research literature.

All these articles are in but a few of the numerous best-known areas of research that Grothendieck cared to work in. Whatever area he touched, he brought revolutionary changes in the very way to think about the basic concepts and ensuing approach to build everlasting structures thereof. He convinced the world of the existence of deep-rooted theories lying behind many a significant result of yester years. The

influence of his extremely original ideas and the power of his unusual insight into deeper aspect of a theory, with a clear perception of still deeper interconnections between different areas, etc., cannot be quantified. It is indeed a miracle of this century that such magnificient work, in diverse directions with a profound unity of thought and simplicity of fundamental concepts, all sprang from a single mind in not more than just two decades. These impressive volumes are a befitting tribute to the miracle mind and an excellent feast even to an onlooker in the world of mathematics, let alone the workers in the specific areas.

The brief (two-page) biographical sketch of Grothendieck in the foreword to Volume I is the least each student of mathematics should know as a matter of general information. The seven-page list of papers, books, seminar proceedings, etc., give an idea of his published work. This is only a partial picture of the actual work since a lot more remains unpublished as yet. Let us hope all of it will be published sooner or later.

In the first article of Volume I, Dieudonné briefly narrates the exceptionally outstanding fundamental contributions of Grothendieck beginning with his first functional analysis to the ultimate algebraic geometry, in chronological order, explaining the beautiful outfit and great strength Grothendieck provided to the whole landscape.

To facilitate a quick reference to the reader of the titles of the articles contained in the entire three-volume set, the list of all the 35 papers is given in each volume.

The organisers of this commendable job, seem to have, for understandable reasons, left out some areas like functional analysis, commutative algebra, etc. However, it is common knowledge that the contributions of Grothendieck are no less epoch-making in these areas as well. It is therefore for the respective specialists to fill the gap to provide a fairly reasonable picture of the universally acclaimed influence of Grothendieck in the major mathematical developments of our times.

Needless to say, these special volumes will be a proud addition and of immense value to a university–institution library in general and where research is a part of the curriculum in particular. Let us record our appreciation to the organisers for their splendid job.

The following are the contents of the three-volume set.

Volume I: Foreword; Bibliographie d'Alexander Grothendieck (Publications of Alexander Grothendieck); (1) J. Dieudonné, De l'analyse fonctionnelle aux fondements de la geométrie algébrique (From functional analysis to the fundamentals of algebraic geometry); (2) A.B. Altman and S.L. Kleiman, The presentation functor and the compactified Jacobian; (3) M. Artin, J. Tate and M. Van den Bergh, Some algebras associated to automorphisms of elliptic curves; (4) V. Balaji and C.S. Seshadri, Cohomology of a moduli space of vector bundles; (5) A. Beauville, Sur les hypersurfaces dont les sections hyperplanes sont à constant (On the hypersurfaces that are the hyperplane sections of a constant module); (6) A.A. Beilinson, A.B. Goncharov, V.V. Schechtman and A.N. Varchenko, Aomoto dilogarithms, Mixed hodge structures and Motivic cohomology of pairs of triangles on the plane (7) P. Berthelot *et* W. Messing, Théorie de Dieudonné cristalline III: equivalence theorems and plain faithfulness; (8) J.–M. Bismut, H. Gillet and C. Soule, Complex immersions and Arakelov geometry; (9) S. Bloch and K. Kato, L-functions and Tamagawa Numbers of motives; (10) L. Breen, Bitorseurs et cohomologie non Abélienne (Bitorsers and non-Abelian cohomology), and (11) J.–L. Brylinski, Non-commutative Ruelle–Sullivan type currents.

Volume II: (12) P. Cartier *et* A. Voros, Une nouvelle interprétation de la formule des traces de Selberg (A new interpretation of the Selberg trace formula); (13) C. Contou–Carrére, Jacobiennes généralisées globales relatives (Global relative generalised Jacobians); (14) P. Delinge, Catégories tannakiennes (Tannakian categories); (15) T. Ekedahl, On the Adic formalism; (16) G. Faltings, F–Isocrystals on open varieties: results and conjectures; (17) J.–M. Fontaine, Représentations *p*-adiques des corps locaux (1ére partie) (*p*-adic representations of local fields (first part); (18) H.A. Hamm and L.D. Trang, Rectified homotopical depth and Grothendieck conjectures; (19) Y. Ihara, Automorphisms of pure sphere Braid Groups and Galois Representations; (20) L. Illusie, Ordinarité des intersections complétes générales (Ordinariness of general complete intersections); (21) M. Kashiwara, Kazhdan–Lusztig Conjecture for a symmetrizable Kac–Moody Lie Algebra; (22) V.A. Kolyvagin, Euler systems, and (23) R. Langlands and D. Shelstad, Descent for transfer factors.

Volume III: (24) A. Lascoux, Anneau de Grothendeick de la variété de drapeaux (Grothendieck ring of the flag variety); (25) S. Lichtenbaum, New results on weight–two motivic Cohomology; (26) G. Lusztig, Symmetric spaces over a finite field; (27) Z. Mebkhout, Le théorème de positivité de l'irrégularité pour les $\mathcal{D}_X$-modules (The positivity theorem of the irregularity for the D_X-modules); (28) A. Ogus, The convergent topos in characteristic p; (29) A.N. Parshin, Finiteness theorems and hyperbolic manifolds; (30) M. Raynaud, p-groupes et réduction semi-stable des courbes (p-groups and semi-stable reduction of curves); (31) G.B. Shabat and V.A. Voevodsky, Drawing curves over number fields; (32) L. Szpiro, Sur les propriétés numériques due dualisant relatif d'une surface arithmétique (On the numerical properties of the relative dualiser of an arithmetic surface); (33) R.W. Thomason and T. Trobaugh, Higher algebraic K-Theory of schemes and of derived categories with Appendix A: Exact categories and the Gabriel–Quillen embedding, Appendix B: Modules *vs* quasi-coherent modules, Appendix C: Absolute nonetherian approximation, Appendix D: Hypercohomology with supports, Appendix E: The Nisnevich topology, Appendix F: Invariance under change of universe; (34) A. Treibich *et* J.–L. Verdier (avec un appendice de J. Oesterlé), Solitons elliptiques (Elliptic solitons (with an appendix by J. Oesterlé)) Appendix: and (35) Yu.G. Zarhin, Linear simple Lie Algebras and ranks of operators.

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A group-theoretical method for nonlinear dynamical system by A.N. Loznov and M.V. Saveliev, Birkhauser Verlag, CH-4010, Basel, Switzerland, 1992, pp. 530, SFr 198, Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110 017.

In this book, a group-theoretical approach is developed for nonlinear evolution equations, based on two basic aspects of the theory of Lie algebras and Lie groups and their representations. They are grading and parameterization of the Lie algebras. The first two chapters contain all the relevant basic results (without proof) on Lie algebras and Lie groups, gradings, parameterization, embeddings, representations, highest vectors of irreducible representations and introduction to superalgebras.

In Chapter 3, a general method of integrating two-dimensional nonlinear systems is given. The method basically depends upon the general properties of graded Lie algebras and Lax-type representations; more specifically, upon integrations based on the 'spectral properties' of the operators (Lax operators) entering in the representation and taking values in a z-graded Lie algebra. The construction of general solitons for systems associated with both the finite and infinite dimensional Lie algebras is outlined.

In Chapter 4, different versions of Toda lattice have been obtained, associated with various finite-dimensional Lie algebras. The complete solutions of two-dimensional generalized Toda lattice is discussed in a detailed way for both periodic and fixed end points. Associated differential–difference equations, like the Lotka–Volterra equation (difference KdV), have been considered as a Bäcklund transformation of the Toda lattice. On using this connection, the general solution of Lotka–Volterra equation has also been obtained.

Representing nonlinear systems on supermanifolds is realized by the elements of an appropriate Lie superalgebra. Accordingly, the integration procedure is generalized. However, this procedure is not general because there is no uniform 'parameterization' of the structure constants of a Lie algebra and also there is no general description of all their grading. Hence, the authors look for other underlying group structures for nonlinear systems (Ch. 5). That is given a system of equations, what is its group of internal symmetries? The criterion for complete integrability of the systems with nonlinearities of a particular type takes the form of a condition imposed on the Lie–Bäcklund algebra of these equations and is equivalent in 'some sense' to the solution of the classification problem of Lie algebras. This is then achieved for all exponential diagonal systems. Explicit solutions are constructed using a perturbation method.

In Chapter 6, the authors suggest a general scheme for constructing solitons of dynamical systems withou referring to the matrix realization of the Lax-type representation. The L–A pairs are replaced by a systen of linear equations of higher dimension in only one scalar function and that their compatibility condition i the equation of the initial dynamical system. To every irreducible representation of the algebra such a linea system can be assigned. The general construction is illustrated with the generalized periodic Toda lattice.

In the final chapter (ch.7), quantum systems are studied. Here, dynamical systems have been investigatec in the Schrödinger or Heisenberg representations. As in the classical case, the existence of Hamiltoniar formalism helps one to use perturbation theory. The required dynamical quantities are obtained in terms of a perturbation technique. With the help of Yang–Feldmann formalism quantum Liouville equation is solved.

This book contains a lot of interesting results, obtained by using methodologies which are not very familiar to nonlinear scientists. Such methods will definitely help the further development of the field. The main criticism of the book is that a lot of results has been collected together without referring to the natural development of the theory with proper motivation. In the reviewer's view, these results could have been formulated in a more systematic way so that the book would have become more attractive and more useful. In any case, it will serve as a good reference for those who are working on the Lie algebraic aspects of nonlinear evolution equations.

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Optical computing in Japan by S. Ishihara, Nova Science Publishers, Inc., 283, Commack Road, Suite 300, Commack, New York 11725, 1990, pp. 524, $98.

The volume is an excellent collection of papers reporting experimental work from Japan in optical computing and the devices used in it. Since the Japanese are in the forefront of optoelectronic research and development, especially in regard to devices and fibre, it is worthwhile for all involved in optoelectronics to know and benefit from what is being done in Japan. A majority of the research work from Japan is published in Japanese and hence is out of bounds to the English-speaking world. This work, which puts together papers from various active groups in Japan on their current activities is thus especially welcome.

The book is divided into five sections for convenience. They are: (i) General fundamentals, (ii) Systems, (iii) Interconnects, (iv) Devices, and (v) Materials.

The introduction with general fundamentals provides an excellent opportunity to refresh us on the capabilities and limitations of optical computing. What quantum state devices, the ultimate tools of optical computing, do and the importance of quantum state control through photons are well explained. All the papers, excepting those under Materials and analogue systems, are concerned with the implementation of a digital computing system with the available optical techniques and devices. Papers by Ichioka & Tanida, Yatagai & Suzaki and Kurokawa deal with exploiting the inherent parallelism in any optical system for implementing a digital system with parallel processing capability. Communication amongst the processors, and the input and output which is a very important aspect of any computing system is dealt with in the three papers presented under interconnects. The role of optical waveguide in providing chip-to-chip and board-to-board communication in an optical computer and also for implementing an array processor is brought out in the papers presented.

Japanese contribution in optical devices and materials is brought out in the next two sections. Spatial light modulators, microlens arrays, laser diode arrays, optical bistable devices and light modulators using liquid crystal and guided waves are some of the topics covered under devices. Organic materials which exhibit large nonlinearity are discussed in the three papers under materials.

The papers are of high standard and contain very useful experimental results. As a collection of research publications in the area this book will be very useful for any group actively working in optical computing.

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Our solar system by Joshi Rana, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp. 141, Rs 250.

Over the past many years, it has been persistently noticed in almost all parts of the world that innumerable number of students at various levels of education and large section of the lay-public along with several members of the scientific community have been expressing eagerness and enthusiasm to know more about the celestial objects in real time in an interactive manner. The necessity of watching the actual objects in the sky with the naked eye as well as through the telescope has also been very strongly felt. Countless number of people wanted to simply know about the stars, the constellations, the planets, the comets and many other objects in the night sky that can be seen with the unaided eye. One of the best ways of catering to such needs is to have some material which starts at the basic level. It would perhaps be more effective if the approach is made utilising the non-formal and simple techniques of conveying the relevant information. This is one such book which can be basically categorised as belonging to this kind of semi-popular scientific literature.

Extending an open invitation to the unfolding story of the solar system, this book starts with many probing questions along with a sincere statement that this is a never-ending story. Commencing with some basic definitions regarding the luminous and non-luminous objects in the sky, it goes on to describe many naked-eye phenomena like, for example, the shift in the timings of the sunrise and correspondingly of the sunset which are caused by the Earth's orbital motion around the Sun with a tilted axis of rotation. While explaining the difference between the diurnal and the true motions of the visible planets, terms like forward motion and retrograde motion (*i.e.*, when the planet appears to move backwards) have been brought out succinctly. After enumerating the physical and astronomical parameters of the Earth, some unfamiliar features like its magnetic field, the dynamics of its interiors and the difference between a solar day and a sidereal day are also touched upon.

In order to identify and study the planets in a starry background, it is necessary to know the positions of the stars. For this, some astronomical coordinate systems are required which are briefly described along with terms like precession and nutation. These are, in fact, related to the peculiarities in Earth's rotation which cause a change in the stellar coordinates, though minutely, over a given period of time. In addition, the star charts of the twelve Zodiacal constellations are very thoughtfully given and the technique of finding the position of the Sun with reference to these constellations is also explained.

Various physical aspects of Sun like the sunspots, the magnetic field, the prominences, the flares and its motion in the Galaxy are briefly described along with varieties of eclipses in the Earth–Moon–Sun system. The phases of Moon are also explained with very simple examples.

The parameters of the planetary orbits and the laws governing them, which are known as Kepler's laws, have been outlined including the historical development of their understanding. The updated version of the basic features of the various planets along with the related space explorations conducted over the past few decades are given indicating that the manned space flights to the planets farther than Mars will remain a far cry for several decades to come. The comets, meteors and other small particles in the interplanetary space are generally described.

The tools of observation, like the optical, radio and the space telescopes, are briefly mentioned giving some idea about the facilities available in India for carrying out astronomical work.

The size of our solar system and its location in the Milky Way Galaxy are described in a simple manner using scaled-down dimensions. The enormity in finding a solution for the question related to the existence of life elsewhere in the Universe is clearly shown with brief descriptions of programmes like CYCLOPS and SETI (search for extraterrestrial intelligence). Finally, the narration closes with problems like the solar neutrino puzzle which is actually a discrepancy between the observed and the theoretically calculated solar neutrinos, the origin of the sunspots, the appearance of Jupiter's red spot at the same place for over 300 years, the source of the extra energy output (also called the super radiation) from Jupiter and Saturn, the cause of the reversal of the magnetic field in some planets and the origin of the solar system itself, all of which have been put forward as open questions with no conclusive answers at present.

The various illustrations and the blue-tinged box items are appropriately used for bringing several not-so-easy points to the level of general educated public. The large number of photographs, both colour and halftone, have been judiciously placed at the relevant positions.

This book makes a nice reading at a popular level explaining many astronomical concepts with down-to-earth every-day examples and without resorting to any technical complexities. It is written in a simple style and can be used very effectively by the students, teachers and many other interested people as a quick introduction to the solar system. It can be an asset to any library, especially where beginners in astronomy can have an access to. Though the price is a little too high, it is one of the good books of its kind presently available in India.

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Solid state electronic engineering materials by S.O. Pillai, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp. 388.

The volume under review is a good textbook, useful to students in many ways. The subject has been developed in essentially a class room style and this is understandable as the book is an outcome to class room lectures delivered by the author for many years. The level of discussion is kept 'less than the brilliant student' and therefore many intricacies in conceptual development are avoided.

The book has eight chapters. In the first introductory chapter, a historical introduction to 'Materials' is given. The treatment is cursory and no references are made to historical details. In the second chapter, atomic structure is reviewed. The atomic models developed by Bohr and Sommerfeld, the quantum numbers, and the periodic table are described. Most of the calculations are worked out step by step and offer no difficulty to the student. In the third chapter, the nature of interatomic forces and chemical binding in solids are described. The properties of materials based on chemical bonds are summarized. In the next chapter, the concepts of symmetry, unit cell, lattices, space groups are developed. There is also a brief description of the impurities, defects and dislocations. Some more details of formation of defects, effect of heat-treatment on defects, strength of materials, colour centres, etc., would have been useful. *Quasicrystalline* materials could have been mentioned.

X-ray diffraction techniques are described in the next chapter. X-ray diffraction from amorphous substances, low-angle X-ray scattering and rotating anode arrangements would have been interesting additional topics. The electrical properties of materials are then discussed. The discussion here also is at the basic level. It would have been nice to look at the basic definition of metal, interfacial effects, metal–matrix compounds in some more detail. The next chapter on the thermal properties of solids is again a standard chapter. The last chapter is on the basics of superconductivity. It is surprising that there is no mention of oxide superconductors although the book has been written in 1991. There is no mention of Josephson junction and SQUIDS.

One redeeming feature of the book is a set of review questions and problems at the end of each chapter. This facilitates the student in a better understanding of the topics described in the book. I would have

wished the book to contain the newer materials also—optoelectronic materials, polymers, magnetic materials, ceramics and biomaterials. The processing technologies and experimental details of synthesis, characterization and measurement should also be generally included.

On the whole, the book is a basic, class-room textbook for students who want to have the first course on traditional solid-state electronic engineering materials.

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Heat and mass transfer: Proceedings of the 11th Heat and Mass Transfer Conference edited by A.R. Balakrishnan and S. Srinivasamurthy, Tata McGraw-Hill Publishing Company Ltd, 4/12, Asaf Ali Road, New Delhi 110 001, 1992, pp. 439, Rs.450.

The papers presented at the 11th Heat and Mass Transfer Conference held at Madras on December 21–23, 1991, have been covered in this volume. It consists of ten sections. In the first, there are seven papers on natural convection. Two of them are concerned with free convection from fins. There are papers on free convection in porous medium, in electronic cooling of equipment, and electrohydrodynamic augmentation. The most interesting paper in this section is on a simple model for turbulent Bernard convection with finite conductivity boundaries. The second section deals with conduction and radiation. There are five papers covering a wide range of problems. The most unusual paper in this is on the use of finite element approach to estimate heat-transfer coefficient in the out casing of steam turbines. In Section 3, there are six papers on boiling and condensation and all of them are concerned with experimental data. In section 4, there are seven papers on heat-transfer augmentation. Two address the issue of enhancement in boiling heat transfer while others are concerned with augmentation in single phase flow. Six of the seven papers report experimental work while one is concerned with numerical simulation.

In Section 5, there are seven papers on numerical heat transfer. Section 6 has 15 papers which are devoted to nuclear reactor heat transfer. The most interesting paper in this section is related to the experimental investigation of thermosyphon in a 235-megawatt pressurised heavy water reactor at Narora. In Section 7, there are four papers on mass transfer, one each on parameter estimation and void fraction measurement. The paper on the use of gamma-ray tomography to measure void fraction is interesting. In Section 8, there are six papers on forced convection. The paper on the use of finite element method to study developing turbulent flow in a pipe provides useful insight. In Section 9, there are eight papers related to energy applications. The most interesting paper is devoted to the energy analysis of a captive power plant of a fertilizer unit. The last section has five papers devoted to heat-transfer problem related to applications in space. There are papers related to performance of heat pipe, INSAT-2 spacecraft, calorimeter and nozzles.

This book provides a good overview of the variety of problems in heat and mass transfer being tackled by different research institutions in India. The production quality is excellent. However, the quality of papers is highly variable, while some are excellent, most are of a pedestrian nature.

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Humans and machines in space: The vision, the challenge and the payoff edited by Bradely Johnson, Gayle L. May and Paula Korn. American Astronautical Society, 1992, pp. 193, $50(hc). Orders to Univelt Inc., PO Box 28130, San Diego, California 92198, USA.

The volume represents the proceedings of the 29th Goddard Memorial Symposium held at Washington, DC, in March 1991. Keeping in view that the Goddard Symposia discuss the forefront topics of space technology and exploration, the theme of the present symposium is no exception. As man prepares to go into space—to work, to live and to explore, an evaluation of the interaction and capabilities of humans and machines is a topic worthy to ponder about. How the two work most effectively and productively together? What actions must be accomplished directly, what activities are interactive/interdependent, and why? The volume presents these issues in the context of near-Earth orbit, lunar and Martian activities. Associated activities include work environments and living in habitats, issues pertaining to economic, educational and technological developments and gains, and above all an appeal for the continuation of interest to explore new space frontiers.

There are 18 articles and a conference summary in this volume. The topics are divided into four subheadings—Introduction, the Vision, the Challenge and the Payoff. The introductory articles point out the need to seriously consider questions like what is it which we wish to achieve in space, how to go about it and its importance to the community as a whole. In achieving the space objectives a careful choice of man *vs* machine has to be made. The Advisory Committee on Future of the US Space Program, popularly known as the Augustine Committee, recommends human space flights only for jobs which can be done by no other way. Wherever possible automatic spacecraft run by people on the ground should be deployed.

In 'Vision', there are two articles, one pertaining to the human exploration of Mars and the other on Cybernetics. A 14-year PERT chart of the exploration program, including a study of the Moon, and human round trip to Mars using ion thrusters as propulsion systems, is envisaged. The program examines alternatives of availability/non-availability of water on the Moon and its subsequent use as a fuel after electrolysing to hydrogen. For the journey to Mars with a three-person crew, the plan calls for 15 months flight using a sprint trajectory; departing from an Earth orbit in May 2003 and returning in July 2004 after spending a month on the surface of Mars. The total run-out cost over the 14-year period is estimated to be $90–125 bn. The program projected is certainly ambitious. The actual longest continuous period spent by any human being in space being almost of the same order, *i.e.*, about a year, the authors assume no serious health problems to the crew members. The article on cybernetics discusses the ways to achieve increased synergism between the human and the machine and concludes that the human should always remain the master of the machine. The automation and computer systems should only extend human capabilities, never replace them.

The major requirements of the manned trip to Mars program are discussed in the next section, 'The Challenge'. As anticipated the crew will have to spend unprecedented periods in microgravity environment exposed to space radiation. Problems pertaining to health and life support systems become detrimental to such a mission, besides, of course, the proper functioning of the spacecraft systems and human–machine interaction. The exploration strategy, therefore, will require advancements in various fields, such as, in regenerative life support and radiation protection, propulsion and power systems aerobreaking, *in-situ* resource utilization, communication, and management, etc. How to go about achieving some of these requirements has been the subject of discussion in this section. A rather detailed article on the role of virtual reality in planetary exploration is also included.

The 'Pay off' section includes articles relating to the influence of space research on education, society and human–machine partnership. An article by the famous writer, Alvin Toffler, on the impact of space program on society is thought-provoking. He states, "American space activities were initially greeted with tremendous popular enthusiasm but, unlike the computer, the space program has lost rather than gained support. It has become less rather than more accepted by society". He thinks, "Americans love space but it is naive to describe the vast and most unmeasurable efforts of the space enterprise as uniformly beneficient". However, he believes that "a sharply focused and strongly financed program is absolutely

essential not just for America's future but the world in general." Another article in this section examines the roles of humans and machines and how the partnership between the two in space can best be exploited to benefit scientific research and terrestrial technology. The strength and weakness of the two are compared.

Besides discussing the various technological issues, the volume clearly makes a case for the continuation of interest in space activities especially by the younger generation. The relevance of space program *vis-a-vis* the removal of poverty and hunger on Earth, has been argued time and again. The spirit of human adventure, however, dictates that man cannot remain bound to Earth for ever. It is this aspect which has been emphasized, perhaps rightly so, in this Symposium. The non-technical nature of the presentations makes interesting reading. The contents will be appreciated by scientists, researchers, space lovers, and policy makers. As is usual with AAS publications, the volume is bound in hard cover, having an attractive illustration of the artist's concept of a propellant extraction system on Phobos.

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History of rocketry and astronautics edited by Frederick I. Ordway, AAS History Series–Vol. 9 (Series ed., R. C. Hall). Published for the American Astronautical Society by Univelt Inc., PO Box 28130, San Diego, CA 92128, 1989, pp. 318, $50 (hc), $35 (sc).

Like the previous volumes in this series, this comprises the proceedings of some of the History Symposia of the International Academy of Astronautics, namely, the ninth, tenth and eleventh held during 1975–1977. Twenty-two articles related to history of different areas in space technology and classified into five parts constitute this volume. The contents cover a wide range of topics, for instance, from 'aeromedical weightlessness' to hardware realization of rockets. A distinguishing feature of this volume is that many of the authors have been, in fact, associated with the history that they are talking about either by personal involvement in the work or by their intimacy with the peers in the field.

History, especially the history of technologies as depicted in this volume, is more than a mere academic curiosity. There are many lessons to be learnt. Some important ones are: how to start from zero, how to conceive and plan the different stages of development and weight technological options and how to proceed undaunted by repeated failures. History of rocketry and astronautics is abundant in such examples, for the space technology has undergone a metamorphosis from fiction to reality and further to a commercial proposition in a short time span of a few decades part of which is almost contemporary! Amidst the heaps of information that such a book would naturally contain, the exceptional ones stand apart unmistakably. For instance, Tsiolkovsky's name recurs in most of the articles irrespective of whether the authors are from the East or the West. He dreamt of space travel, built liquid propellant rockets, contemplated of using hydrogen as a fuel, knew the complexities of heat transfer and cooling techniques and so on. Similarly, the impact of V-2 rocket on the post-war developments in rocketry is mentioned several times in this volume. Assimilation of V-2 technology seemed to have been almost an obsession to war-time allies for some time after 1945.

An impression that gains ground after reading this volume is that there have been two distinct periods of importance as far as rocketry and astronautics are concerned. The first one lasted through the 17th and 18th centuries and the second through the 20th century. Of course, there have been studies and developmental efforts in other times beginning from the 13th century as many articles and bibliographies indicate, but it was during the first phase of the 17–18th century AD that foundations of mechanics were laid by eminent scientists like Kepler, Euler, Lagrange, Newton and several others (Ch. 5). In the 20th century,

particularly after the Second World War, rocketry and astronautics have taken such rapid strides that even the present generation is still in a state of shock unable to comprehend all that is happening in this field. As Rauschenbach puts it, it is possible that future historians will place our age as the era of 'Opening up of space' (Ch. 21).

For those interested in upper-atmospheric research and sounding rockets, this volume would be of special interest. There are nine papers directly related to this field—quoting Mirtov Vedeshin (Ch. 15) "just 1–2 per cent of Earth's gas envelope attracting so much of attention". Among these, the papers on early atmospheric research with rockets (Ch. 11), Skylark rocket (Ch. 12) and on grenade and falling sphere experiments (Ch. 14) deserve a special mention. There are some lucid narrations in this volume that would interest any reader even if one has no background of rocketry. The British Operation Backfire (Ch. 10) and the biographical sketches of Kepler Harry Bull and others (Ch. 19–22) fall into this category.

On the whole, this book contains excellent articles catering to a wide section of students and scientists in space technology. None of the articles can be termed as difficult reading! The fact that there has been a gap of 12–15 years between the Symposia and the publication of the AAS-History volumes makes one wonder if it would not be better if AAS brought our books more on thematical basis after regrouping the articles from various symposia.

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