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BOOK REVIEWS

Quality in science edited by Marcel C. La Follette. The MIT Press, Cambridge Massachusetts, U.S.A., 1982, Pp. 250, $ 12.50 (Asia price $ 14.40).

Kepler's remark that 'the mind comprehends a thing the more correctly the closer the thing approaches toward pure quantity as its origin' or Kelvin's belief that 'if something cannot be quantitatively measured it cannot be understood' rationalises man's urge to assess quality in terms of quantity, magnitude and number. Impossible though it may look at the first sight, it is no more so than Newton's master-stroke that took such abstruse terms as *force*, *work* and *energy*, redefined them in terms of a few equations and brought order in previous confusions.

Systematic attempts to quantify the quality in science or the subject of scientometrics is hardly a decade old. However, basic science has had its own quality control for long. This internal check on quality based on *peer review* has enabled science to weed out the mundane and the ephemeral. It is but rarely that a Labachevsky or a Mendel is brought back from oblivion to immortality. Otherwise a creative scientist unlike his colleague in humanities stands a better chance of enjoying the fruit of his labour within his life time. This better fate of being recognised early is the outcome of a very rigorous intrinsic assessment based on *peer review*. However, in advanced countries like USA such internal quality control applies only to five per cent of total scientific work. How about the rest, especially the applied science which consumes the overwhelmingly large proportion of the total R & D expenses?

The book under review is the outcome of an attempt to define suitable quantitative criteria for the quality of applied science. It deals mostly with the problems of external assessment, or, in other words, the assessment of science by the society at large. The questions of priorities and goals, of fundings and control, of progress and values are raised and discussed threadbare. The book contains broad spectrum of views. While on the one hand Prewith wants the 'attentive public' (eighteen per cent of the adult population in USA) to act as science lobby to extract more funds, to set

priorities and goals and to resolve the conflict between science findings and social values, Yankelovich, on the other hand, is for democratisation of the same. He wants the majority of the populace to actively discuss the entire gamut of man's scientific persuits. Here is Morison attempting to give numerical marks (magnitude) to the quality of various science projects, as well as Mazlish trying to make quantitative assessment using historical analogies or employing case studies to answer 'before-during-after' questions. And there is Weingart tracing the erosion of the power of scientist in framing science policy. Contributions from a couple of politicians add to the flavour of this assorted dish.

This book is relevant only in technologically advanced societies where fantastic progress in science has also brought in its wake sufficiently matching potential for mischief to merit a relook into the quality control of science. In most of the developing countries science is in a nascent stage and its impact on society could be blissfully ignored. Countries like India form yet another category. It has a large science base and yet that base enjoys a 'benign negligence' from society compared to the intense public scrutiny their western colleagues are subjected to by the 'attentive public'. Bereft as it is of the external assessment, the internal assessment of science is also not much in evidence thus making it a haven for mediocrity and a heaven for technocrats in government R & D laboratories (and these are the agencies which spend almost the entire national budget on science R & D) who suffer no threat of accountability. To them the present volume only increases their list of books for casual reading. "Well, thought provoking but not much of relevance," would be their comment.

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Quest—An autobiography by Leopold Infeld. Chelsea Publishing Company, New York, 1980, Pp. 361, $ 14.95.

This is the second edition of the absorbing autobiography of a great scientist which first appeared in 1941. The present edition carries an epilogue which is taken from an article published by Infeld in 1965 in the *Bulletin of Atomic Scientists* and explains why he left Canada after having settled there.

Infeld had a very turbulent life and his narration is extremely captivating. Born a Jew in a leather merchant's family in Cracow ghetto of Poland, he gives a vivid account of a ghetto life—how so-called patriotic Polish youth beat Jews because they are hated and treated as enemies of the country. Infeld had a very hardlife in

wth, with luck and rare determination on his part he studied and became a scientist theoretical physicist). But he had to go through the military service of the Austrian my. After this service he looked forward to the future for a quiet academic life. But he became a victim of anti-semitic and reactionary forces. His personal taste of this is beautifully described.

In book two (Escape) he deals with his slow alienation and eventual escape from Poland to England and then to USA and Canada. This also has the most poignant account of his relationship with his first wife Halina—her illness and death. The death of Halina makes Infeld extremely disturbed and he is on the verge of emotional and nal breakdown.

His description of Cambridge life and scientists, particularly that of PAM, Dirac s most authentic. It was here that Infeld came in contact with Max Born, another ewish victim of anti-semitism. Here, they collaborated (after a quarrel) and ublished their famous work which is known as Born-Infeld Unitary Field Theory. e briefly returned to Poland as a successful Physicist—but the growing anti-semitism rove him away again and this time to America.

The most notable contact that Infeld established here is with Einstein in Princeton. He started a fairly durable collaboration first on the best selling exposition—*The Evolution of Physics* (1938)—a classic. Finally he got a distinguished job in Canada happily married second time to an American woman, named Helen and had two Canada-born children. His description of Einstein is again very authentic—the unparalleled detachment of Einstein from everything wordly—except his deep involvement in his scientific pursuit. As Infeld remarks 'scientists have their prejudices, different social views and different ethical standards'. There were scientists who supported Hitler and faked experiments. Yet there were others—aloof, gentle and men such as Einstein, Bohr and Dirac. After a fairly placid and comfortable academic life in Canada where he occupied a very eminent position—he was caught in a serious controversy because of an article he published. He was accused of being a communist and labelled as a 'traitor'. The epilogue is a defiance of his position.

They went back to Poland and he became the Director of an institute and remained there till his death. To sum up, Infeld's autobiography is remarkable in many ways. It is vivid and engrossing—whether he is dealing with ghetto life, anti-semitism, corrupt academy life or describing notable scientists like Einstein and Dirac. The narration is captivating because of its dramatic quality and sincere and honest account of human failings and greatness told in a forceful style.

The reviewer enjoyed reading it the second time and recommends it strongly to scientists and laymen.

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Third workshop on grand unification (University of North Carolina, Chapel Hill, USA) edited by Paul H. Frampton, Sheldon L. Glashow and Hendrik van Dam, Birkhauser Verlag, P.O. Box 34, CH–4010, Basel, Switzerland, 1982, Pp. 373, S. Fr. 50, Indian Orders to Allied Publishers Pvt. Ltd., New Delhi 110002.

One of the most vigorously pursued activities in Particle Physics for the last two decades or so has been the idea of unification of basic forces of nature. With the success of Salam-Weinberg-Glashow unified theory for electromagnetic and weak interactions the hope is stronger that a unified picture of all the basic forces is within our reach. The volume under review summarises the present state of art in this area. Most importantly, the situation with regard to proton decay experiments, pioneered by the Indo-Japanese team at the Kolar mines, have been reported in seven papers. The Kolar experiment has claimed some candidate events. Only one candidate event has been seen by Mont-Blanc experiment which was reported at the XXII International Conference on High Energy Physics at Paris in July last year. There have been no positive reports from other experiments so far.

Besides proton decay experiments, the status of the CERN experiments for the measurement of neutrino mass by radiative electron captive has been covered by de Rujula. The neutrino-oscillation experiments at accelerators, covered by Herbert Chen, do not show any $\nu_\mu \to \nu_e$ or $\nu_e \to \nu_\mu$ appearance modes, nor any $\nu_e \to \nu_\tau$ disappearance mode. Also the lowest experimental upper limits on the neutrino mass from tritium decay have been discussed by Simpson. In addition to decaying protons the baryon number violation predicted by grand unified theories can be studied in the spontaneous conversion of a neutron to an antineutron. The experiments looking for this effect, performed at the Los Alamos National Laboratory (USA), have been reported by H. Anderson.

The one monopole candidate with Dirac value of magnetic charge $\frac{1}{2} eg = \hbar c$, has been reported by Blas Cabrera. The experiment has been discussed by him in great detail. Unfortunately, it is an only one event claim with no corroboration from any other source. It is difficult to judge if this single event finally turns out to be a genuine monopole. A possible origin of the monopole flux due to a slow evaporating from the Sun has been discussed by Sheldon Glashow.

For the last few years, there has been much interest in extending the grand unification ideas to incorporate supersymmetry. This is essential to ensure stability of the various mass scales that appear in the conventional versions of grand unification models. It is a solution to the gauge-hierarchy problem of Gildener. This theoretical development in the context of grand unification has been very popular for the last two years and has been reviewed in six papers in the present volume. The most important problem in this area, that of supersymmetry breaking has been covered by Steven Weinberg. He has obtained cosmological bounds on the supersymmetry breaking scale and also discussed the role of gravity in this context.

Overall, this volume presents a clear picture of both theoretical and experimental work that has been done in the area of grand unification theories up to the time of this workshop.

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Gauge theories : **Fundamental interactions and rigorous results** edited by P. Dita, V. Georgescu, R. Purice. Birkhauser Verlag, P.O. Box 34, CH-4010, Basel, Switzerland, 1982, Pp. 369, S. Fr. 50. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

This volume contains the proceedings of the 1981 Summer School of Theoretical Physics, Poiana Brasov, Romania. In the continuing search for the appropriate theoretical framework in which to describe the fundamental interactions among the ultimate constituents of matter, it now seems that both the strong and the electroweak forces may be formulated as quantum gauge field theories. However it is also clear that the initially assumed gauge symmetry has to be spontaneously broken, to accord with the facts. Gauge symmetry and spontaneous breakdown have led, in combination, to the circumstance that already at the classical level one deals with Lagrangian field theories with unusual solutions characterised by novel topological properties, and connections to many areas of modern mathematics. Keeping these developments in mind, the organizers of this School have concentrated on four major themes : Gauge theories of fundamental interactions ; Geometry of classical Yang-Mills fields ; Methods in constructive field theory ; and related topics. Most of the contributions are highly technical and use mathematics of a kind unlikely to be familiar to a physicist with a conventional training. On the other hand, the treatments are, by and large, not sufficiently comprehensive and self-contained to enable one to learn the subject from this volume. Thus these proceedings are not in the class of, for instance, the Brandeis, Cargese, Erice and Les Houches Summer School series. The reader must already be somewhat familiar with recent developments in particle theory to derive some benefit from this volume. Having said this about the flavour of the contents of this book, the particularly valuable contributions may be pointed out. The account by P. C. Taylor of the Standard Electroweak Theory—the Weinberg-Salam model—is distinguished by its critical approach emphasizing several 'scandalous' features which one tends to ignore because of the success of the theory. The lectures by D. I. Olive on 'The structure of self-dual monopoles'—are a very lucid account of the author's important research work on classical spherically symmetric solutions of spontaneoulsy broken gauge field theories. They bring out the perhaps surprising connections of this topic to Lax pair equations and the Toda molecule. S. Ferrara gives a brief and useful introduction to supersymmetry—a principle uniting bosons and fermions into one multiplet. He describes the supersymmetry algebra and the superspace formalism

for handling supermultiplets and supersymmetric Lagrangians. The second group of lectures involves heavy mathematics. M. F. Atiyah and A. Jaffe both return to the aspects of self-dual solutions to gauge field equations. The former—a renowned mathematician—introduces us to the Penrose transform, a new weapon in the mathematician's armoury to handle special types of partial differential equations in four dimensions. In the section on constructive field theory, K. Osterwalder gives a well-organized account of the aims of axiomatic quantum field theory and of recent results in constructive quantum field theory for scalar fields. Especially the links to the Euclidean formulation and to classical statistical mechanics are brought out. E. Seiler's lectures deal with the case of Fermi fields. Finally under Related Topics one must mention the brief account of Geometric Quantization by D. J. Simms, emphasizing the key steps in the mathematician's attempt to put the heuristic procedure of canonical quantization on a firm foundation.

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N. MUKUNDA

Fusion (Science, Politics and the invention of a New Energy Source) by Joan Lisa Bromberg. The MIT Press, Cambridge, Massachusetts, Pp. 344, $ 34.50.

Since the year 1946 a new source of energy has been in the making world over. In the initial phases, the research in this area of nuclear fusion was a closely guarded secret. Every scientist and every group leader was of the view in those years that the success of nucelar fusion was round the corner. The progress, of this particular research, in the absence of mass contact with the scientific community, was slow. The fusion scientists of 50's were severely handicapped because of this phenomenon. However, they were themselves to be blamed. They were so egotistic that they thought the final glory will slip away if results were made public.

This book is a story of the fusion research. It could not have been told in a better way. It brings out the human failings on the one hand and undue concern for international prestige on the other. Until the early seventies the programme's real motive in the mind of funding agencies' peers had been to outbeat the British and the Russians. If a ripple of British or Russian success story had found its way into the halls of Washington, it immediately resulted in more Dollars for the American laboratories. The fusion research in the three countries followed their own independent paths, each country being very sure of its own line of thought and action. Not only that, each laboratory in U.S.A. doing its own independent research on the plasma machine of their choosing, thought that only they had the final answer. Because of limited budgetary provisions it led to severe inter-laboratory rivalries. The author narrates an incident when the British-American scientist Tuck and the grand old Messiah (of

plasma physics) Layman Spitzer were made to talk to each other in a formal meeting to sort out their scientific differences. Each one of them knew their limitations, yet no one said so in public. The laboratories were often found over ambitious in their capabilities in order to keep their respective scientists busy with work. As yet there was no strong central controlling agency in Washington to curb this trend. This is not to say that there were no down-to-earth scientists who did not share the views of their leaders. These scientists were later to prove to the community that it always paid to indulge in honest assessment of their own work.

The development of plasma devices did not wait for the basic physics of plasmas to uncover itself. To emphasize the point even today some of the vital aspects of the physics of confinement has eluded understanding. From the physicists' point of view the key to the fusion is diffusion and instabilities and the consequent confinement time and the densities involved through the Lawson criterion. The engineering problems of working reactor had remained in the background until the relative success of TOKAMAKS. the contribution of Russians. In a rare meeting of minds of the capitalist system with that of the leftists, the Americans were convinced of the success (or the relative success) of the TOKAMAKS. In a short span of four months Princeton's Stellarator was converted into a TOKAMAK device with an on-line computer which the Russians did not possess. The Princeton group under Gotleib, Spitzer and Six were about to overtake every one else with a mass of data for the theoreticians to explain and understand. Success was round the corner. Because of pressure from the Congress Coppi's team at MIT, Clarke at Oak Ridge and Drummond's group at Austin, Texas, joined the TOKAMAK band wagon. It was in Texas TOKAMAK that the turbulent nature of plasmas was to be exploited for the purpose of heating the plasmas. Mirror machines had been under great pressure right through this period. But these survived at Livermore under Post and at Oak Ridge under Clarke. However, other devices like Astron were not to survive. Termination of Astron even resulted in the tragic demise of its leader.

Even though independence of the major laboratories was eroded during the reign of Hirch and Dean in Washington, it helped in producing results which further resulted in obtaining more money from the Congress. No money worth any mention came from the private industry except the Texas Fusion Foundation.

Somewhere on the line after declassification phase, the University research in plasmas got a big boost through the championship of persons like Reseublath—the Pop. It contributed in a big measure to the understanding of plasmas. Plasma science is now passing through the happiest times from the point of view of funding as well as understanding of the subject.

The book is written for every one to read without any background in plasmas. The author has done a remarkable job of it. The story of fusion has been told in a way that one would want to read it entirely in one sitting like a mystery thriller.

I found on page 242 electron written as election and on page 253 (at the bottom) the sentence is incomplete. On page 251, third paragraph, 9th line, the figure of $1 million is certainly a misprint. Towards the end of the book, a glossary of common technical terms on Magnetic Fusion is given for easy reference. The subject matter is thoroughly documented either through personal interviews or by referring to the reports, books and journals. A thorough work indeed ! My congratulations to the author on such a successful work in print.

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SOM KRISHAN

Revealing the universe edited by James Cornell and Alan P. Lightman. The MIT Press, Cambridge, Massachusetts, 1982, Pp. xiv + 247, $ 17.50 (Asia $ 20.15).

This book concerns the universe, its origin, structure and perhaps the future. The physics of the universe must involve a close interaction between observation and theoretical analysis. Without this close connection experimentalists will pile a mass of observational data without providing insight into the workings of the universe. Theory, without the support of empirical and observational data, will become idle speculation.

This book provides a collection of articles by very eminent and practicing scientists on a number of topics. These are : Historical tension between astronomical theory and observation, Einstein's perception of space and time, The evolution of the solar system, The puzzle of the sun's corona, Cosmic power house : quasars and blackholes, The age and structure of the universe and finally the three unanswered questions in astronomy.

Each topic is covered by a theoretician and an experimental observationalist. Thus the interconnection is maintained throughout and the reader is exposed to both theoretical and experimental aspects of the subject discussed. This is indeed a great virtue. Furthermore, the topics are brought to the most exciting current status of the knowledge unravelled.

This book is no doubt a valuable contribution to the man's understanding of the universe.

It is strongly recommended to scientists interested in this field.

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Spectral methods in linear transport theory by H. G. Kaper, C. G. Lekkerkerker and J. Hejtmanek, Birkhauser Verlag, Basel, Switzerland, 1982, Pp. 345, S. Fr. 52.

It is a monograph of 345 pages devoted entirely to the time-independent and time-dependent linear transport theory with special reference to neutron transport in reactors. It is addressed to applied mathematicians and makes extensive use of linear operator theory and functional analysis. The formulation of the problem as well as its treatment is at a rather abstract level and physicists in general may find it rather hard to appreciate the full power of the formalism. Personally, I would have liked to see some discussion of the elegant method of invariant imbedding as developed in the context of radiative transfer. Recommended for libraries serving chemical engineers, applied mathematicians and physicists.

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Arithmetic applied mathematics (Volume 1 in the International Series in Nonlinear Mathematics : Theory, Methods and Applications) by David Greenspan. Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 OBW, England, 1980, Pp. 165, $ 11.25.

The title of this book does *not* contain a typographical error ; the author uses the word arithmetic as an adjective, to indicate that everything in the book involves only arithmetical operations, and no calculus. The author's approach is well stated in his Preface : " ··· we will develop a computer, rather than a continuum, approach to the deterministic theories of particle mechanics .... At those points where Newton, Leibniz, and Einstein found it necessary to apply the analytical power of the calculus, we shall, instead, apply the computational power of modern digital computers.... The simplicity of our approach will yield simple models of complex physical phenomena and solvable dynamical equations for both linear and non-linear behaviour. The price we pay for such mathematical simplicity is that we must do our arithmetic at high speeds." (Note that the author's 'continuum mechanics' is *not* the mechanics of continuous media, but particle mechanics using differential equations.)

In effect the author handles difference equations rather than differential equations but it must be emphasized that he is not writing merely finite difference approximations to those differential equations. For example, in discussing falling bodies, the velocity at time t_K,

$$v_k = v(t_k),$$

is defined through the average

$$\frac{v_{k+1} + v_k}{2} = \frac{x_{k+1} - x_k}{\triangle t};$$

but the acceleration at time t_k is defined *not* analogously, being taken instead as

$$a_k = \frac{v_{k+1} - v_k}{\triangle t}.$$

Similarly. Newton's law of gravitation takes on a somewhat unfamiliar form; for example, the component in the direction x of the force between two bodies at distance r_k at time t_k is given by

$$F_{k,x} = - \frac{Gm_1m_2(x_{k+1} + x_k)}{r_k r_{k+1}(r_k + r_{k+1})}.$$

It is true that these expressions tend in the limit as $\triangle t \to 0$ to the familiar, classical expressions. However, there are other expressions with the same property, and the author does not explain in sufficient detail why he picks the ones he does. The unifying idea that determines the choice appears to be the potential, in the sense that it has the simple form

$$V_k = - Gm_1m_2/r_k.$$

While it is fascinating to see how many of the phenomena that we are familiar with through the use of differential equations (this includes planetary motions, heat conduction, elastic vibrations, etc.) yield very suggestive results using the appropriate particle arithmetic, it is only for simple forces such as gravity that the continuous and the arithmetic approach yield exactly the same dynamical behaviour. In general the two approaches yield results which differ by terms of order $(\triangle t)^3$ for both position and velocity (p. 31). I am not sure therefore how deep studies of this kind can be taken to be ; in particular, it is difficult to see how the 'arithmetic' approach can displace the 'continuous' approach of Newton *et al.*

At places, in fact, the author claims too much. For example, Section 4.5 deals with laminar and turbulent fluid flows ; and the author traces on the computer the motion of a series of particles (more precisely Lennard-Jones type molecules) emitted from a nozzle, with a small random perturbation imposed on the exit velocity. The trajectories of the particles show a certain chactic behaviour, which is fascinating, but what one seems to be analysing here is the Liapounov instability of particle motion and not turbulent flow of a fluid : it has not been shown anywhere that the two are related. The author even discovers vortices from these trajectories, but does not explain how or why such vortices arise—if in fact they do at all—as there appears to be no angular momentum, vorticity or diffusion in his model.

There are other places as well where the treatment is not convincing. For example the occurrence of shock waves is discussed by considering the motion of a piston moving 'at a very high rate of speed' (*sic*) in a cylinder head. Although the

geometry is at first discussed in terms of a tube which is 100 units long, 10 units high, etc., all of a sudden results appear at time $t = 0 \cdot 1$ *seconds* : it is not clear how physical units suddenly materialized in the problem. A rather unrealistic reflection strategy is used for particles that encounter the surface of the cylinder or the piston, and the reader is confused about what exactly in the model causes shock waves.

The book includes discussion on a variety of other problems, some in a cursory way ; but four chapters deal with relativistic mechanics.

In summary, a large number of phenomena can be quickly and vividly illustrated on a computer using the author's simple difference equations. In an age when computers are getting cheaper and commoner all the time, the author's 'arithmetic' suggests excellent ways of introducing students to the complex and fascinating behaviour exhibited by even simple dynamical systems. But considerable caution is necessary in relating directly the behaviour so computed to complex natural phenomena.

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Tata lectures on theta I (Progress in Mathematics, Vol. 28) by D. Mumford. Birkhauser Verlag, P.O. Box 34, CH-4010 Basel, Switzerland, 1983, Pp. 235, S.Fr. 54. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

Written by one of the greatest mathematicians of our time, this highly laudable book contains the first two chapters of an intended survey (with four chapters) of the theory of theta functions ; it is based on the author's lectures at the Tata Institute of Fundamental Research during 1978–79 and subsequently at Harvard and Montreal. While Krazer's Lehrbuch der Thetafunktionen and the Krazer–Wirtinger Enzyklopaedie article are well-known and time-honoured source books for theta functions, the main existence theorems on theta functions were deeply investigated, in the late forties, by Conforto, Siegel and Weil giving natural proofs. A completely algebraic and elegant theory of theta functions (in any characteristic $\neq 2$) was developed, in the sixties by the author, in the same direction as Weil's purely algebraic theory of abelian functions. Using theta constants and derivatives skilfully, Siegel established that a finite set thereof could be used to separate points on the quotient variety of Siegel's (g, g) upper half-space by a modular group ; the author's algebraic theory however avoided invoking derivatives for this purpose (even for characteristic 0). Ten years after Igusa's excellent book on 'Theta functions' appeared, we are fortunate to have this beautiful monograph on theta functions in several variables, which includes the most recent results and is also pleasant to read.

Chapter I explains the interest evoked by theta functions (and their link with the Heat equation and representations of the Heisenberg group), considers Riemann's theta functions $\theta(z, \tau)$ with the variants in great detail and explains their use in imbedding the torus $C/(Z + Z.\tau)$ in complex projective 3-space and the realisation of the equations for the resulting curve ; a very interesting presentation of Riemann's theta relations (being undoubtedly some of the most significant from the veritable 'labyrinth' of theta relations) is also provided. The functional equation for θ under the action of the elliptic modular group is then discussed carefully and the realization therefrom of the moduli space of 1-dimensional tori as an algebraic curve is given. Jacobi's famous identity on the z-derivative of θ follows this, together with applications of theta series to arithmetic : combinatorial identities from the product expansion for θ, Jacobi's formula for the number of ways of expressing a natural number as a sum of 4 squares of integers and Hecke theory connecting modular forms with Dirichlet series.

Chapter II entitled 'Basic results on theta functions in several variables' gives generalizations of the geometric results of Chapter I. Theta functions are used to imbed g-dimensional tori X in projective space and when X arises from a compact Riemann surface R of genus g, θ is related to the function theory on R. The functional equation for theta functions and Riemann's theta formulae are then established, leading to a determination of the defining equations for X as an algebraic variety. Using quadratic forms and pluric-harmonic polynomials, theta functions give rise to a host of modular forms.

The second volume will deal with Jacobian (and, in particular, hyperelliptic) theta functions and the representation-theoretic and algebro-geometric aspects of the theory.

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Mathematics for the analysis of algorithms (Second Edition) by Daniel H. Greene and Donald E. Knuth, Birkhauser, Verlag Basel, 1982, Pp. 123, S.Fr. 24. Indian orders to Allied, Publishers Pvt Ltd., New Delhi 110 002.

This book, co-authored by the well-known mathematician-*cum*-computer scientist D. E. Knuth, on the application of some (relatively) advanced mathematics to the analysis of algorithms, is remarkable in many ways. One finds it a real experience to read the book from the first page to the last, savoring at each step the masterly way in which binomial identities, operator methods and asymptotic techniques are exploited to study algorithms. The presentation of the material, though terse, is stimulating to any mathematically-minded reader. The book can be read with little specific knowledge about computers or computational complexity.

Before going into the contents of the book, it is necessary to have an idea of the primal concept in computer science—the concept of an algorithm.

An algorithm, as commonly understood, is a recipe or specific set of rules or directions for performing a task. (When the task is to be done on a computer, we say we have an algorithm for solving a problem when we can write a computer program that solves it.) While studying an algorithm the basic questions to be answered are : What tasks can or cannot be performed by an algorithm when implemented on a computer with limited resources? What is the computational complexity of the algorithm? The general theory of algorithms is concerned with the properties (like complexity) of algorithms, not with the theory of specific algorithms. As is well known, before attempting a computer run of a program, one would like to have (i) estimates of the storage or run-time for execution of the program in order to avoid aborted runs ; and (ii) a quantitative standard for comparing the merits of algorithms, when many are available to solve the same problem.

The book under consideration deals, not with the general theory of algorithms, but with the mathematical basis for the analysis of specific algorithms. Actually, it is 'a mathematical look at the synthesis—emphasizing the mathematical perspective, but using motivation and examples from computer science'. In this sense, it is quite distinct from the currently available books on computer mathematics. Of course, a considerable part of the material is drawn from D. E. Knuth's *The art of computer programming*, Vol. 3 (Addison-Wesley, 1973), and from research papers scattered in the literature. The authors' attempt to bring, in their inimitable way, apparently diverse but somewhat familiar results together is praiseworthy.

The first chapter, which is the summary of an attempt to discover a coherent scheme in binomial identities, presents inverse relations, operator calculus and hypergeometric series.

The next chapter deals with recurrence relations (finite and infinite history) having constant and variable coefficients. There is a neat description of the use of generating functions in solving linear, constant coefficient recurrence relations. Interesting examples are given to illustrate the solution of nonlinear recurrence relations (involving the evaluation of max and min) which require 'conjecture and insight rather than routine tools'. It is a surprise that Shimon Even's book *Algorithmic combinatorics* (Macmillan Company, New York, 1973) is not referred here.

In Chapter 3, the authors consider the application of operator methods to the 'cookie monster' and other problems related to hashing schemes. One learns how the operator methods enable us to bypass trivial details in the study of algorithms. The two concepts exemplified here are : Eigenoperator and 'induction from the other end', the latter being innovative.

The last chapter (Chapter 4) describes asymptotic methods for approximating the exact solution in the study of algorithms which are not amenable to closed form solutions. The aim of asymptotic analysis is to discover as thorough an asymptotic approximation as possible, the tools used being O-notation, bootstrapping (helpful in situations where there is an implicit equation for a given function cf interest), and dissecting (applied chiefly to sums ard integrals). Examples from algebra, number theory and probability show the power cf the sophisticated techniques used—Riemann zeta function, Möbius inversion, Darboux's ard saddle point methods.

At many places in the text, stimulating problems are suggested, and challenging ones are posed at the end of the book, as Mid-Term, Final and Qualifying Examinations. A unique feature of the book is that solutions to these problems are also given.

The bibliography is relevant and up-to-date. There exist very few typographical errors.

To summarize, the book is an extremenly valuable source of inspiration for research workers in the area of computer algorithms.

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Topics in differential and integral equations and operator theory (Vol. 7 in Operator Theory : Advances and Applications) by M. G. Krein, edited by I. Gohberg ; translated from the Russian by A. Jacob. Birkhäuser Verlag, Basel, 1983, Pp. ix+302, S.Fr. 56 Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

The major part of this volume contains English translation of three important papers of M. G. Krein. It also contains translations of three more of his papers—two of which are with I. C. Gohberg and one with F. E. Melik-Adamyan.

The first, of the three papers of M. G. Krein, deals with the theory of canonical linear differential equations with periodic coefficients. It discusses the question of stability of solutions of linear Hamiltonian systems (bourded solutions remaining bounded under small perturbations). The main ideas used are from the theory of operators in finite and infinite dimensional spaces, ard complex analysis. The original paper appeared in 1955. Some recent literaure related to this paper can be found in *AMS Translation* (2), 1970, **93**, 103–176 and in *Integral Equations and Operator Theory* 1982, **5**, 718–757.

The second paper is actually the collection of six lectures given by M. G. Krein in the First Summer Math. School, Kanev, in 1963. These lectures basically deal with the thoery of spectral shift function, and in wave and scattering operators. They are very lucid and self-contained.

The third paper deals with certain nonlinear integral equations which are closely related to the theory of Wiener–Hopf integral equations. This work originally appeared during 1976–77. This is a sequel to the author's various interesting and significant contributions to the theory of Wiener–Hopf integral equations. Here, the study of linear Wiener–Hopf integral equations is reduced to that of some nonlinear integral equations, which originally started with the works of V. A. Ambartsumyan and S. Chandrasekhar in Astrophysics and Radiative Transfer. This paper not only gives a complete mathematical treatment of these works, but also further extends these studies.

The other three papers deal with (i) the theory of certain linear integral equations in various standard function spaces, (ii) inequalities for the characteristic numbers of integral equations with smooth kernels and (iii) the theory of S-Matrices of canonical differential equations with summable potential.

Though two of the three major papers of Krein were originally written over two decades ago, they hold a significant position in the literature. As is rightly pointed out in the editorial comments, 'the passage of time has not decreased their value..... These papers contain a wealth of ideas and will serve as a source of stimulation and inspiration for experts and beginners alike'.

All these papers are self-contained, filled with a variety of ideas and information, and are written in the author's typical lucid style (qualities which have become a trade mark of all the papers of M. G. Krein).

This volume will, without any doubt, be an excellent addition to any researcher in Differential and Integral Equations and is a must for every library.

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Elements of the theory of generalized inverses for matrices by Randall E. Cline. Birkhauser Verlag, P.O. Box 34, CH-4010 Basel, 1979, S.Fr. 10. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

The concept of generalized inverses for matrices play a very significant role in many problems of engineering and physics in which the theory of ordinary inverses of matrices ceases to be inapplicable or inadequate. The author has made a sincere attempt to introduce the concept of generalised inverses of various types for matrices in a simple looking (size-wise) elegant monograph which is readable and enjoyable by readers of all forms—beginners or users.

The book contains four main chapters dealing with the actual subject-matter and is supported by a chapter on Introduction dealing with the motive for generalised inverses and various notations utilized in the other chapters, and two Appendices giving hints to some of the difficult exercises in the book and a list of useful references respectively.

Each article in the book is very carefully written for beginners as well as users of the subject and is followed by a number of well selected solved and unsolved problems to clarify the matter in a nice way.

The geometrical illustrations in Chapter 2 dealing with Moore–Penrose inverses have been demonstrated in a very enjoyable manner.

As a whole, the book is written with utmost care and will serve as a basic text-book for students taking a course in the subject of generalised inverses for matrices.

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Multivariate approximation theory (II) edited by Walter Schempp and Karl Zeller. Birkhauser Verlag, Basel, 1982, Pp. 240, S.Fr. 60. Indian orders Allied Publishers Pvt. Ltd., New Delhi 110 002.

With the rapid development of computers and with their extensive use in solving scientific problems, the interest for doing research in Approximation Theory has grown very fast in the past two decades. During this period, many text-books were written and proceedings of conferences were published. The aim of the subject is to approximate functions of several variables, their derivatives and/or some of the quantities associated with them, their averages for instance. It is desirable to do this in such a way that the whole procedure can be easily fed into a computer.

The present volume is an attempt in this direction. This constitutes the proceedings of the Third International Conference on Multivariate Approximation Theory held at Oberwalfach, 1982. The papers presented cover a wide range of problems and methods, both classical and modern, in the subject. There are articles which deal with uniform and mean square approximations of continuous functions on product spaces by polynomial or piecewise polynomial functions. In most cases, explicit calculations of basis functions were done. This ought to be very useful for numerical analysts. Quite a few articles are devoted to the study of spline approximations and interpolation. One lecture is concerned with the approximation of eigenvalues of self-adjoint operators in Hilbert spaces ; another one gives an answer to the question: when a converse set is a Chebyshev set ? [(*i.e.*) each point in the space has a unique

nearest element in the convex set.] This kind of approach may lead to another point of view for the study of regularity of solutions of certain variational inequalities.

Numerical quadrature is the topic of study of certain number of articles. This is very essential in finite element method, which depends heavily on weak formulations of the boundary value problem. One article which gives methods to evaluate integrals on spheres should find application in boundary element method. The construction of numerical quadratures using Max Noether Theorem in algebraic geometry is something new. So is the idea of getting error estimates in numerical quadrature using bi-orthogonal systems.

Numerous applications of the theory and methods given in this volume are very interesting to pure and applied mathematicians alike. They include some classical problems like the evaluation of analytic continuation of a function of a complex variable using interpolation techniques, domain of dependence theorems for hyperbolic equations using some non-standard polynomial approximations, the convergence of the Fourier series to the function and so on. Another useful application is that of vector splines in estimating upper air vorticity and divergence. This is given in the last article of the volume.

There are two articles which study approximations by finite element method. One is about the construction of C^k finite elements for arbitrary integer $k \geq 0$. This generalizes the existing C^1 finite elements which are constantly used in the conforming finite element method. The other one takes up a very important and difficult study of the behaviour of the constants which appear in the error estimates in finite element method. Indeed, without this knowledge various error estimates obtained are not very useful practically !

Apart from presenting classical methods and modern trends in the current research to tackle problems in the subject, this volume also gives up-to-date references in the literature. In addition, numerous open problems have been indicated to the readers in various talks. In view of all these, this book is highly recommended to any research library of applied mathematics and numerical analysis.

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Branching processes by S. Asmussen and H. Hering. Birkhauser Verlag, P.O. Box 34, CH-4010, Basel, Switzerland, 1983, pp. 461, S.Fr. 82. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

This book augments the current literature on branching processes with a detailed account of the works of the authors on branching diffusions and related models. It is a welcome addition to the existing books on branching processes and researchers in this area should find the book extremely useful.

The book is divided into four parts. Part A, the shortest, contains an introduction to various branching models with emphasis on applications. Part B contains a detailed discussion of the limit theory of the Galton–Watson and the continuous time Markov branching processes. Even though the material is fairly standard, the discussion here is more elaborate and contains several new proofs. In particular, there are three proofs of the Kesten–Stigum theorem (stating that the limit random variable W of the Galton–Watson process is non-zero iff the usual '$X \log X$' condition holds).

Part C entitled 'Multigroup branching diffusions on bounded domains' is the main part of the book ; it contains the basic theory of branching diffusions due to the authors, including limit theorems for such processes. In the words of the authors the aim of this part has been 'to treat a large subfield to the highest degree of generality and completeness possible'. In particular, this part includes the construction of the branching diffusions due to Ikeda, Nagasawa and Watanabe which was hitherto unavailable in book form. Processes with infinite set of types are discussed here for the first time. Examples of the process discussed in this part include the multitype Bellman-Harris and the Sevastyanov processes, but not the Crump–Mode–Jagers (C–M–J) branching process. This latter process is treated separately in part D, Ch. X. Part D discusses some special models. It begins with the examples of branching Ornstein–Uhlenbeck process and branching Brownian motion wherein the conditions of part C (for the validity of the limit theorems) are not satisfied. It then discusses the generalized age-dependence (The C–M–J process) and random characteristics, containing the works of O. Nerman in the supercritical case, Doney in the subcritical case and Holte and Green in the critical case. Multitype versions are also given. Finally, an attempt is made to study two sex models which are known to be much more complicated than the unisex models.

In conclusion, the book is an excellent addition to the existing literature on branching processes. It might be noted, however, that for a highly technical book of this size, an index would have been very useful, if not absolutely necessary.

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Applied probability–Computer science : The Interface—2 volumes, edited by Ralph L. Disney and Tuenis J. Ott, Birkhauser Verlag, Basel, Switzerland, 1982. Vol. I—pp. 532, Vol. II—pp. 514, S.Fr. 88 each volume. Indian orders to Allied Publishers Pvt. Ltd., New Delhi 110 002.

In the evolution of engineering sciences, many research groups have developed their perspectives in pursuing the same area without much of an interface among them. As an example, statisticians, communication engineers and time series analysts have worked in the area of signal processing evolving their particular methodologies without much of communication among them. Some years ago, a concerted effort was made to bring these groups together. Similarly, in the present day there are many computer scientists who believe that probability is beyond their domain. As a result, in many curricula involving computer science, probability courses are absent or/are at a very minimum level. However, in the international arena the computer scientists and applied probabilists have come to work on similar problems developing similar approaches and tools without prossibly trying to cross fertilize each other. Realizing this lacuna, the Operations Research Society of America (ORSA) and The Institute of Management Sciences (TIMS) had organized in 1981 in Florida a joint meeting between these two groups. The proceedings of this first meeting have come out as a two-volume book.

Forty-five papers from researchers from around the Western world are included in these two volumes. The striking area of common methodology between these two groups is the network of queues. More than half the papers are in this area. The rest are in other functional areas, which are fast becoming a source of exciting research problems, like computer performance analysis, data networks, data base analysis, analysis of communication protocol, mixed voice-data telephone networks, probabilistic analysis of algorithms and reliability.

The first eight papers are of a survey nature presented by invited speakers and covers topics like queuing theory, simulation, memory allocation and analysis of algorithms. The other papers fall into categories like network of queues, queuing models in performance analysis and various other types of models in performance analysis, reliability, probabilistic aspects of simulation, probabilistic analysis of data bases, computational aspects, of probability, probabilistic analysis of algorithms and probabilistic scheduling.

The standard of most of the papers is quite high and most of them give the state of the art as of 1980. There is a wealth of material for any serious research worker to develop further the ideas presented. The publishers are to be complimented for bringing out such a timely publication. In my opinion, these two volumes will be an excellent addition to the library of many educational institutions and research laboratories.

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Probability and statistical inference edited by Wilfried Grossman, Georg Ch. Pflug and Wolfgang Wertz, D. Reidel Publishing Co., Dordrecht, Holland, 1982, pp. viii + 389, $ 49·50.

This book is the outcome of the proceedings of the second symposium on mathematical statistics held in Austria in June 1981. The participants and the authors were all from the eastern part of the Central Europe described as the Pannonian area. Among the 70 papers delivered at this conference 35 are included in the present book. The title of the book *Probability and Statistical Inference* may be somewhat misleading because most of the papers deal with applied probability and estimation theory. The papers cover roughly the following topics : non-parametric estimation theory, asymptotic theory of estimation, invariance principles, limit theorems, optimization, Monte-Carlo methods and different types of statistical tests. There is a solitary paper on stochastic integral representation of a sequence of martingales. Perhaps a more appropriate title would have been 'Applied Probability and Statistical Estimation'.

Most of the papers are either applicational in character using theory already developed by others or extensions to theoretical results obtained elsewhere. Some of the papers are well written while some others are somewhat too terse to be useful. On the whole the quality of papers is good and may be useful to researchers specializing in the mathematical aspects of statistical estimation theory.

It would have been better if there had been a uniformity in the reproduction of papers. Some papers are double spaced, some have one and a half spacing and some are single spaced. The paper, 'One Method of Stable Estimation of a Location Parameter' is so closely typed with hand written mathematical expressions overlapping the typed matter that it is almost very difficult to understand it.

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Complex differential geometry by S. Kobayashi and H. Wu. Birkhauser Verlag, Basel, 1983, Pp. 159, S.Fr. 26. Indian orders to Allied Publishers Pvt. Ltd., P.O. Box No. 155, Asaf Ali Road, New Delhi 110 002.

Part I. Function theory on noncompact Kähler manifolds by H. Wu

An attempt to find a solution of a significant problem in mathematics has often resulted in a wealth of mathematical ideas. The problem of uniformization of Riemann surfaces is one such. It has attracted some of the most illustrious mathematicians of its time and their efforts to solve the problem have given rise to many significant mathematical ideas such as the concept of a manifold, universal covering space and so on

In recent years, an attempt to generalize this theorem to higher dimensions has produced some excellent mathematics which is the subject-matter of the book under review. Before embarking on the detailed analysis of the contents of the book, let me give a brief history of the problem.

The uniformization theorem of Riemann surfaces says that a simply connected Riemann surface is conformally equivalent to the Riemann sphere, the complex plane or the unit disc. It is well known that there is no direct analogue of this beautiful theorem in higher dimensions. By using celebrated Ahlfors-Schwarz lemma and result of Blanc-Fiala-Huber, one can reformulate the uniformization theorem in differential geometric language as follows:

(i) Every compact surface with positive curvature is conformally equivalent to the Riemann sphere.

(ii) Every noncompact complete surface with positive curvature is conformally equivalent to the complex plane.

(iii) Every simply connected (complete) surface with curvature bounded from above by a negative constant is conformally equivalent to the open unit disc.

It is conjectured that with some reasonable curvature assumptions on the manifold the above results have higher dimensional analogue. The higher dimensional analogue of case (i) is known as Frankel's conjecture which states that a compact Kähler manifold of positive sectional curvature must be biholomorphic to the complex projective space. This conjecture was proved by Andreotti-Frankel and Mabuchi in case of dimension two and three respectively. Very recently the general case was proved by Siu-Yau[1].

Corresponding to the case (ii), one has the conjecture that a noncompact complete Kähler manifold of positive sectional curvature must be biholomorphic to some C^n. Siu-Yau[2] proved that a noncompact simply connected Kähler manifold of complex dimension n with $0 \geqslant K \geqslant -A/r^{2+\epsilon}$ must be biholomorphic to some C^n, where A and ϵ are positive numbers and r is the distance from a fixed point of M. Greene-Wu[3] generalized this result to the case $0 \geqslant K \geqslant -k(r)$ with $k(r) \geqslant 0$ and $\int_0^\infty r\,k(r)\,dr < +\infty$.

Corresponding to the case (iii), one has the conjecture of Wu that a simply connected complete Kähler manifold of negative sectional curvature must be biholomorphic to a bounded domain in C^n. A weaker version of this conjecture says that on such manifold there are many nonconstant bounded holomorphic functions. Up to this day, no progress has been made on these conjectures. However, they have,

directly or indirectly, inspired a good part of the work done in this general area in the last fifteen years. A recent construction by Mostow-Siu[4] of a compact Kähler surface of negative sectional curvature whose universal covering is not biholomorphic to the open two ball has shed some light on the complexity of these problems.

Now coming back to the book under review, the author tries to narrate to the reader the fascinating story of the mathematical adventure that failed in its main goal (viz. that of solving the above conjecture) but still produced some excellent mathematics.

I am sure that this book will be of great value to the reader who wishes to be introduced to such treatment of the subject as enables him to grasp the essential features without having to go through the agonizing experience of ploughing through the papers written by masters like Yau, Siu, Wu and many others in the field.

In principle one has to agree with the claims of the authors in the preface that the prerequisites for reading these notes is rudimentary knowledge of Riemannian geometry up to second variational formula, as well as some elementary facts about Stein manifold such as Grauert's solution of the Levi problem. However, in order to appreciate the book, it is essential to possess a considerable amount of mathematical maturity. The author being an active worker in the field seems to have an irresistable tendency to push some of his recent results of utmost generality even before discussing some special cases. The reader may therefore find it difficult in some places to comprehend what is going on. This does not however diminish the usefulness of the book or the interest it sustains.

Background material §0 provides briefly the differential geometric language and some elementary results that are needed in the rest of the book. One can find here a reasonably self-contained discussion of the transition from the Hermitian connection of a given Kähler metric to the Levi-Civita connection of the real part of the Kähler metric, which is not easily accessible in the existing literature.

The first two lectures are concerned with the problem of existence of nonconstact holomorphic functions on certain Kähler manifolds. This is accomplished by obtaining the following two theorems (Wu):

(i) A simply connected complete Kähler manifold of non-positive sectional curvature is a Stein manifold.

(ii) A complete noncompact Kähler manifold with positive bisectional curvature and nonnegative sectional curvature is a Stein manifold. These theorems guarantee the existence of many nonconstant holomorphic functions (just pull back the entire function on C^n *via* the imbedding). The strategy of the proof of both the thorems is to construct a C^∞—strictly plurisubharmonic exhaustion function and then invoke Grauert's solution of the Levi problem.

The third lecture is concerned with the nonexistence of bounded nonconstant holomorphic functions on certain Kähler manifolds or equivalently bounded nonconstant harmonic functions on certain Riemannian manifolds. The main result is Yau's beautiful theorem that a complete Riemannian manifold with nonnegative Ricci curvature carries no nonconstant positive harmonic function. This is the only theorem in the book which is attended to by the author in all its details. The proof is based on Weitzenbock formula and the skillful application of the maximum principle. Another result (of the author) proved here is that a Riemannian manifold with a pole under some suitable assumptions on radial curvature carries no nonconstant positive harmonic function. The proof depends on Harnack inequality of Moser.

The fourth lecture is devoted to the discussion of certain results on simply connected complete Kähler manifolds of nonpositive sectional curvature, one of which confirms the plausibility of the conjecture that if the curvature stays bounded away from zero, then the manifold has the characteristic features of a bounded domain in C^n. More specifically the following theorem (Wu-Greene) has been proved ; If M is complete simply connected Kähler manifold with nonpositive sectional curvature which is less than or equal to $-A/\rho^2$ outside a compact set, where ρ is the distance function relative to a fixed point $0 \in M$ and A is a positive constant, then it is complete hyperbolic and possesses a Bergman metric which is complete when the curvature is suitably pinched. Another result (of the author) discussed here is that a simply connected complete Riemannian manifold of dimension greater than or equal to three with certain restrictions on the sectional curvature (which guarantee that its sectional curvature decays very fast relative to a fixed point) is flat. This generalizes a recent result of Mok–Siu–Yau[6].

The fifth and the final lecture is devoted to the discussion of certain open problems.

Part II. Topics in complex differential geometry by S. Kobayashi and C. Horst

The aim of these notes is to give a concise account of recent results concerning the Calabi conjecture, the existence of holomorphic affine connections, holomorphic projective connections, quadratic structures, conformal structures, holomorphic tensor fields on a complex manifold. This part is in many ways a catalogue of the results of the author and his collaborators scattered in various journals.

Chapter one gives a brief resume of definitions and basic results that are needed in the subsequent chapters. Notable among them are Calabi conjecture and some related results proved by Yau and Aubin.

Chapter two describes briefly the work of the author with M. Inoue. It is shown that the existence of holomorphic affine connection imposes a heavy restriction upon n-dimensional manifold by proving that its chern class c_i must vanish for $i > n/2$ and if in addition the manifold is Kähler, then all its chern class vanish. Further, it is

shown by invoking Yau's solution of Calabi conjecture that such a manifold admits a holomorphic affine connection if and only if it is covered by torus.

Chapters 3 and 4 give brief accounts of characterizations of a compact Kähler-Einstein manifold which admits (i) a normal projective connection, (ii) a conformal structure.

The final chapter (5) gives a brief discussion of the results of Bochner which shows how the definiteness properties of the Ricci tensor impose heavy restrictions on the existence of holomorphic tensor field on a compact Kähler manifold. All these results have been reformulated in terms of the signs of the first chern class using Calabi conjecture.

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Differential geometric control theory edited by Roger W. Brockett, Richard S. Millman and Hector J. Sussmann. Birkhauser Verlag, Basel, Switzerland, 1983, Pp. 340, S.Fr. 62. Indian orders to Allied Publishers Pvt. Ltd., P.O. Box No. 155, 13/14, Asaf Ali Road, New Delhi 110 002.

This book is the outcome of the proceedings of the Conference on Differential Geometric Control Theory held at Michigan Technological University during June-July 1982. There were 76 participants who discussed the application of differential geometric methods to nonlinear control theory problems and the recent progress in this field. The papers consist of both old ideas and new developments.

Half the book consists of monographs by Hector Sussmann and Robert Gardner. The other half consists of ten papers by the control theorists and geometers amongst the participants. The monograph by Sussmann consists of control theory and very little of differential geometric aspects. The control theory presented consists of the following basic ideas: (*a*) treating control system as a collection of vector fields forming dynamical polysystem, (*b*) characterizing the coordinate invariant properties in terms of the structure of the Lie-algebra generated by the vector fields. (*c*) treating the local and global consequences of real analyticity and (*d*) extending the results of linear system theory for nonlinear systems. The author exploits the properties and structure of Lie-algebra and Lie-brackets to characterize linear control systems and explains the presence of certain Lie-brackets in the case of nonlinear systems. Since the author starts from basic fundamentals the exposition is very clear and entremely well presented. Since the Lie-algebraic characterization of nonlinear filtering results is under active research now, this paper will certainly form a link between control theorists and nonlinear filtering workers.

The second main paper by Robert Gardner goes into the techniques of differential geometry and exterior differential systems. The paper consists of six chapters. The first chapter is an introduction to differential geometric methods and simple applications to control theory and calculus of variations. The next three chapters deal with Pfaffian systems and applications to Monge systems arising in control theory. The last two chapters discuss Cartan's method of equivalence and application to the calculus of variations of curves.

The other ten papers including that of Roger Brockett are on (*a*) asymptotic stability and 'feedback stabilization', (*b*) control theory, inverse spectral problems and real algebraic geometry, (*c*) on the existence of globally-invariant distributions, (*d*) noncommutative generating power series, Chen series and filtered transitive Lie-algebras in the local realization of nonlinear systems, (*e*) secondary characteristics of locally flat bundles, (*f*) analytic bounds for sub-analytic sets, (*g*) design for multi-input nonlinear systems, (*h*) controllability of affine systems, (*i*) generic properties of extremals in optimal control problems, (*j*) robustness in nonlinear control. As mentioned before some of these papers are pedagogic and some of them give some original results.

For people who are specializing in the area differential geometry applied to control theory this book will be a very good addition.

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Abstract algebra by N. P. Chaudhury. Tata McGraw-Hill Publishing Co. Ltd., 12/4, Asaf Ali Road, 3rd Floor, New Delhi 110 002, 1983, pp. 152, Rs. 69.

This is a good introductory textbook intended for students who begin their college mathematics. It has six chapters—sets, groups, rings, vector spaces, lattices, and fields. The concepts are clearly explained with appropriate examples of a strictly elementary level. A minor gap on page 35—that the S_{on} of a transposition is $= -1$ does not seem to have been verified at all. Misprints—(p. 34) $(-1)\ \gamma_a$ (Theorem 2.5.7) Cayley's. The price is rather high compared to Indian editions of the foreign publishers.

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The basis of organic chemistry (Second Edition) by R. J. Fessenden and J. S. Fessenden, Allyn and Bacon, 42, Colebrook Row, London N1 8AF. 1978, $ 11.95. Indian orders to UBS Publishers' Distributors Ltd., 5, Ansari Road, Box 7015, New Delhi 110 002.

The authors have emphasised the reactions of types of bonds and how they occur instead of using the traditional approach. Because the book is directed toward students with varying backgrounds and interests, the authors have treated reaction mechanisms from a visual standpoint rather than a mathematical one. This is highly commendable.

In view of the vast interest of present day students in biologically-oriented fields such as genetics or the study of the drugs, emphasis has been laid on some of the biological applications of organic chemistry.

In the present revised edition, Chapter 1 has been expanded to give a more detailed review on bonding. The discussion on physical properties in Chapter 18 has been deleted to accommodate a slight expansion of spectroscopy, NMR in particular. A few additional topics have been added. The *E*–*Z* and (*R*) (*S*) systems of nomenclature are introduced briefly as are the subjects of prostaglandins, insect pheromones and photosynthesis.

The book is divided into 18 chapters. The different subjects covered in each chapter are : The covalent bond, isomerism, nomenclature, acid–base reactions, substitution and elimination reactions, addition reactions and reductions, reactions of carbonyl compounds, stereochemistry, shapes of cyclic molecules and optical isomerism, sugars and other carbohydrates, amino acids and peptides, nucleic acids and the chemistry

of heredity, introduction to metabolism, organic compounds occurring in nature, the action of drugs and spectra of organic compounds.

This book is directed towards the student who has had a background in general chemistry. The authors have intentionally introduced material that may be a review for many students. They have tried to build a firm foundation for an understanding of why reaction occurs.

Another useful aspect of this book is the number of study questions included at the end of Chapters 1 through 9. These are some typical questions but not exhaustive. A review of important organic reactions is made in Chapter 10. Students will find this chapter very useful. Answers to some of the problems are appended. A dependable subject index is another attractive feature of this book. There is no doubt that this is a very useful and comprehensive book on organic chemistry.

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Study guide to organic chemistry by Morrison and Boyd (Third Edition), Allyn and Bacon, $ 12.95.

This is a guide to problems given in the text book of organic chemistry by Morrison and Boyd. The answers have been systematically worked out with suitable explanations. This will help the students to find out where they have gone wrong, in case they do not get the right answers. With a few answers, references to chemical literature have been given with a view to enable the student to look up the original papers, if necessary and if they are curious.

The guide is recommended for students as a reference book.

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Proceedings of the Fourth International Congress of Quantum Chemistry edited by Per-Olov-Lowdin and Bernard Pullman. D. Reidel Publishing Co., Dordrecht, 1983, pp. vii + 457, $ 67.50.

The Fourth International Congress of Quantum Chemistry which was held on June 14–19, 1982 at Uppsala, Sweden, consisted of six symposia in various areas of quantum chemistry, solid-state theory and quantum biology. The proceedings therefore contain

papers in various areas and each area has now become so specialised because of its growth that it becomes impossible for a single reviewer to review all the areas with equal competence.

The proceedings contain six sections. In the section entitled 'Quantum mechanical methods', Lirderberg's paper shows, probably for the first time, that it is possible to estimate chemical reaction rate from the principles of quantum mechanics. In this paper, the advantage of the hyperspherical coordinates has been stressed. The same section along with the section 'Computational quantum chemistry' emphasises on the methods of dealing with electron correlation. For a long time chemists are generally familiar with the configuration interaction methods for dealing with electron correlation and with its diadvantages. Methods based on the cluster anasatz for an exact wave function are quite impressive in dealing with the problem of electron correlation. An extension of the coupled cluster approach to the open shell systems has been shown although it requires a considerable computational effort.

One of the latest and impressive developments in computational quantum chemistry is the calculation of energy derivatives and its potential application in the detection of transition state and saddle point on the reaction surfaces. Although in the time-dependent section, new theoretical techniques are discussed for understanding molecular reaction dynamics, the application of the calculation of energy derivatives has of late expanded dramatically and may continue to draw the attention of chemists for many years to come.

The section on large molecules and solid state theory seem to suggest that accurate calculations of the electronic structure of clusters built up from various atoms may serve as a future junction between quantum chemistry and solid-state theory. In this content, a wider application of the pseudo-potential quantum chemical approach for the treatment of medium size clusters is called for. Unfortunately, not a single paper on the pseudo-potential approach is found in this proceedings.

In the section of 'Quantum biology' an article on evolution of molecule is seen. This is certainly an interesting article in the field of molecular biology but I do not see any relevance of this article to quantum biology because nowhere any quantum chemical principle is involved. Only article which fits in this proceedings is that of R. Lavery and A. Pullman on the distribution of the electrostatic field and potential around tRNA, the most complicated molecule.

In spite of the fact that the articles are written by the specialists, they are of general interest to physical chemists, organic chemists and molecular biologists.

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The forgotten third skill by Marcelle Kellerman. Pergamon Press, 1981, pp. 129, Price not stated.

Foreign language teaching in the past has invariably emphasised the acquisition of the 'productive' skills of speaking and writing. Structure and phonetic drills through the oral method have been used to teach language. Reading has been a neglected skill. There has been, as Kellerman puts it, a belief that reading in a foreign language is difficult for most children, that it cannot give pleasure, that it is time consuming and not really necessary', and that 'since success in the form of examination passes can largely dispense with fluent reading as a skill in its own right, why bother?' This speaks of the general apathy foreign language teachers have shown towards reading as an imparted skill. Ms. Kellerman starts with the premise that 'children have an innate ability to understand much more than they know, and to know much more than they often given (sic) themselves credit for' thus dismissing fears and misgivings, so frequently expressed about reading, as 'discriminatory and baseless'. The book suggests a major change in language didactics so that reading can become 'a central objective of our foreign language programme after the first oral phase...an activity accessible to, and to be enjoyed by, all learners literate in the mother-tongue ... on the condition that we put them in a situation where they can clearly demonstrate their aptitude'.

Speaking and writing are easy to teach and provide tangible yardsticks for assessing achievements ; listening and reading are more difficult to teach and to test. The mechanistic character of the oral method, however, even though appropriate at the initial language learning stages, relies too much on 'transient recall capacities' and develops only a temporary ability and not any enduring linguistic competence. We may compare the 'drills only' student to 'a traveller who receives verbal directions and walks on slowly, repeating them in his mind. Whether they stay in his mind or not will depend on his memory' (A. J. Thomson and A. V. Martinet, *EFL Bulletin*, No. 4, O.U.P.). A crucial psycholinguistic implication here is that children cannot learn to understand language by imitation or rote because meaning is not directly represented in the sounds that they hear. Language can be better understood through the application of syntactic rules and these can be assimilated and internalized by reading and comprehending carefully selected written materials. The reading text, as H. G. Widdowson says, 'realizes linguistic rules by reference to the principle of extension···' and makes 'the utterance meaning clear by providing other utterances which are complementary and extensive (Contrived and Natural Language, *EFL Bulletin*, No. 4, page 8). Reading would also allow pupils to explore the world of knowledge through the medium of the foreign language and build for themselves a storehouse of experiences in terms of which they can process the texts that they read subsequently. As Kellerman puts it, 'Greater success would surely be achieved if our foreign language courses encouraged self-reliance in pupils and appealed to developing and more enduring interests'. Reading being a student-centred activity, leads to 'independent

thinkirg ard creativity'. It liberatcs the pupil from the confines of the classroom drills ard exposes him to a more extensive contact with language than is possible in oracy. This develops in the student the requisite backing and confidence to handle larguage situations in his environment and at his stage of training. Ms. Kellerman laments the neglect of the third skill, reading and this neglect, she feels, 'may well account for the relatively poor linguistic achievements of foreign language learners'.

In order to make a readirg course effective, the book gives certain axioms on which teachirg strategies should be based. The axioms pertain to the 'socio-pedagogy of foreign larguage readir g' and speak of a carefully 'defined pattern' of the reading course, 'of well defined stages', 'frequency' of reading, 'accessibility of reading to all pupils literate in the native language', 'relevance of reading content', 'availability of varied and extensive literature', 'availability of time and space for intra-and extra-curricular reading' and 'encouragement and recognition of the effort made by the learner'. There must also be appropriate and reliable methods for testing pupils' active and passive knowledge of the target language.

Efficient reading is normally done in terms of three sources of information from the text—semantic : reading in order to comprehend meaning ; syntactic : the way words are strung together in sentences : and, graphic : letter and word perception. These skills are to be taught in an interdependent way so that each can aid the other. Learning to read and to speak and understand langauage can go hand in hand as complementary activities held together by a framework of meaning.

There has to be a period of preparation before pupils can enter the reading phase. Kellerman suggests that for the pre-reading phase pupils would have had approximately three terms of oral instruction at the rate of 30 minutes a day, and a method of teaching which encourages them to think and feel independently in the foreign language and to speak it with the minimum of effort. In the reading phase, the literature selected should harmonize with the aptitudes, needs and aspirations of young pupils: 'It should be of good quality, linguistically sound, rich in imagination and authentic in its message or plot.' The starting point in reading must be a story or description which is held together by a logical development and arrives at a climax or conclusion. General understanding of the basic tale must be ensured. To achieve this the author suggests five steps or 'Moments' as she calls them : four 'Moments' of guided reading and comprehension followed by a fifth one when unaided reading is envisaged. The reading phase would lead to semi-liberated and liberated reading situations where 'the pupil has access to and enjoys reading unedited genuine foreign literature'.

The book is divided into convenient sections arranged in a logically developmental order which makes comprehension and acceptance of her argument easy and smooth. The six chapters are : The case for foreign language literacy ; Experimental background ; Theoretical bases of planning reading programmes ; Practical approaches ; Implications for teacher training ; and, Summary of conclusions. The style is persua-

sive and the plan convincing. The author does not indulge in any abstract philosophy while building a case for reading. On the contrary, her approach is a practical one based on certain experiments she conducted in some schools in Yorkshire. She acknowledges her debt to Julian Dakin whose work in India and Spain opened up new possibilities in the quest for different emphases in language didactics. Julian Dakin died in 1972 at the age of 31. What he had to say was important ; and he had just started saying it. The present work is an attempt to carry on the work Julian Dakin envisaged in his correspondence with Ms. Kellerman. A selection of reading texts, written by Julian Dakin, is given in the appendix. Suggestions for further reading are given at the end of the book.

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