J. Indian Inst. Sci., 63 (B), Oct. 1981, Pp. 227-237.

BOOK REVIEWS

The mathematical experience by Philip J. Davis and Reuben Hersh. Birkhauser Verlag, P.O. Box 34, CH-4010, Basel, Switzerland, 1981, pp. ix + 440, S.Fr. 52.

The progress of civilization over the past five thousand years has been linked with the accumulation of a vast body of concepts, practices and knowledge known as Mathematics. Such a conglomerate entity has been linked in a variety of conscious and unconscious ways to our day-to-day life. It is only natural that we ask ourselves the question :

What is the nature of mathematics?
What are its meaning and methodology?
How is it created and used?
What are its linkages to the variety of human experience?
What benefits and harm arise from it directly or indirectly?

It is beyond any individual capacity to provide satisfactory answers to all the above questions because the amount of material is so varied and vast and the interlinking so dominant that it is impossible for anyone to get a comprehensive total picture. At best the answers would correspond to the morphic feel of the proverbial blind men who investigated an elephant! Amongst us exists a small number of people who use mathematics professionally and who teach, foster and create mathematics. As a consequence this small group often educate the people for the raison d'etre and the delightful book 'The Mathematical Experience' provides the feel of the "blind men" who individually operate in professional zeal in a variety of specialized areas.

It would be desirable to trace the history and origin of mathematics as it is practised today. The main stream of this discipline was originally confined, between 3000 BC and 300 BC to Egypt and Babylon whence it spread to Greece and Rome in the next eight hundred years. The incentive then passed on to the Islamic countries in mid-east for the next seven hundred years. Strangely enough the spread of this discipline to European countries did not commence until 1100 AD. Again the precise interaction of the mathematics streams from the east notably India and China and Inca-Aztec with the European stream are not known. One of the earliest evidences of mathematical activity goes back nearly four thousand years and is found as a clay tablet in cuneiform writing and excavated in Iraq. This tablet provides the Babylonian method for finding the roots of a quadratic equation.

A naive definition needed for initial understanding of mathematics is that it is the science of quantity and space. In their simpler form they are known as arithmetic and geometry. Beginning with a number of elementary ideas and rules of mathematical and logical manipulation geometry builds up a fabric of deductions of increasing complexity ever since Euclid laid down the pattern in 300 BC. This deductive process is known as 'proof'. Mathematics is then logically defined as the 'science of making necessary conclusions'. The ruler and compass had been built into the axioms of Euclidean geometry and along with arithmetic needed as an instrument of commerce dominated the Greek scene until Ptolemy's time when trigonometry as an off-shoot of geometry was discovered. It was not until the time of Omar Khayyam and Bhaskara in 1200 AD that algebra made its appearance and along with arithmetic, geometry and trigonometry represented the main stream of mathematical activity for the next four hundred years. Seventeenth century can be marked down as an epoch making period when analytic geometry of Descartes, the elements of probability theory of Pascal, the number theory of Fermat, the most important discovery of infinitesimal calculus by Newton and Leibniz, were radically changing the emphasis and direction of the structure of mathematics. The following eighteenth and nineteenth centuries could be termed as the 'golden era' of mathematics which laid down the essentials of what is now termed as modern mathematics. In the process, it shattered many of the earlier concepts and formulations held almost with an awe of divinity from the time of Plato and Aristotle. Complex variables of Euler, calculus of variations of Lagrange, probability theory of Laplace, differential geometry of Gauss, non-euclidean geometry of Bolyai, integration theory and generalized tensor analysis of Riemann, set theory of Cantor, real and complex analysis of Weierstrass, topology of Poincare, theory of mathematical foundation of Hilbert—all these glittering and profound domains of mathematics appeared on the scene. Early twentieth century saw the emergence of mathematical logic formulated by Russel and Whitehead. If the present anthology provides the flavour of the dazzling powers of the human intellect, it would be rewarding to know something of the temper as it varied from the misty period when Church had its omnipotent power and influence on all human affairs to the present emancipated and democratic times. Mathematical Platonism asserts that mathematics exists independent of human beings and mathematician is only an empirical scientist because he cannot invent anything as everything is there. He has at any given moment only an incomplete and fragmentary view of the world of ideas. The concept of the phenomenal world according to the Platonists is totally geometirc and confined to the sense perceptions. Of course, the abstract rationalists and vedantists would differ from this stand when the question of ultimate reality is discussed. On the other extreme is a set-theoretic view of the universe which is steeped in formalism. Mathematics just consists of axioms, definitions and theorems and there are rules by which one derives one formula from another. In a purely mathematical sense, the formula has no meaning and no truth value. In order to understand these opposite stands and the dilemma that threw the formalism of Hilbert, the logicism of Russel and the constructivism of Brouwer into disarray one should follow the development of philosophy of mathematics and of mathematics itself over the many centuries. The crisis is the culmination of a long standing anti-thesis between the traditional ideal of Euclid and the reality of mathematics. Bishop Berkeley recognized this discrepancy in 1734 and in a blistering attack on the infidel Edmund Halley exposed the obscurities and inconsistencies of infinitesimal calculus which fell short of ideas of Euclidean geometry. He considered Newton's ideas as 'obscure, repugnant and precarious'. Berkeley's logic that asserted rightly that the differentials are either equal to zero or not equal to zero and cannot have double characteristics as the scientist chooses, remained unanswered until Weierstrass turned to Euclidean rigor that was devoid of infinitesimal. Subsequently, Robinson developed a new branch of mathematics called 'nonstandard mathematics' which answered many mathematical fallacies. A new chapter was started in the never ending war between the finite and the infinite, between the continuous and the discontinuous.

Abstraction is the life blood of mathematics as Dirac pointed out and is almost synonymous with intelligence itself. In the view of Russel, systematic scholastic theology derives directly from mathematics. In this context, it is very interesting to trace this in the writing of the Babylonian Jew Saadia Gaon who lived in tenth century AD. In addition to being a philosopher and a theologian, he had dabbled in anatomy, astronomy, music and mathematics. Saadia is fascinating because in his systematic theology, the processes of thought which characterized the modern thinking of mathematics for the past two centuries have been already recognizable. For example, concerning his belief that the Creator of all things is one, he says : "the data with which sciences start out are concrete whereas the objectives they strive for are abstract." He insisted that God must be understood only through processes of abstraction. In the role of the abstractor, the modern mathematician continually poses the questions: What is the heart of the matter? What makes the process tick? Saadia arrives at his concept of God in very much the same way and says : "the idea of a creator must be necessity if subtler than the subtlest, more recondite than the recondite and more abstract than the most abstract". He proves the 'existence and uniqueness' of God in a logic that has surprisingly mathematical flavour ! Such logical concepts have a strange correspondence with those of Russel and Whitehead.

The roots of the philosophy of mathematics as of mathematics itself are in classical Greece. For Greeks, mathematics meant geometry and the philosophy of mathematics in Plato and Aristotle is the philosophy of geometry. For Plato, the mission of philosophy was to discover true knowledge through mathematics which itself was independent of sense experience. Strangely enough, the service of rationalism through mathematics to science was that it denied the supremacy of religious authority while maintaining the truth of religion. This stand was challenged by believers in empiricism and materialism like Locke and Hobbs who believed that experiments and observations are the only legitimate means of obtaining knowledge, barring mathematics. John Stuart Mill went a step further and proposed an empiricist theory of mathematics. While the battle between the rationalists and empiricists went on right into the twentieth century, it was left to Russel and Whitehead to claim that only mathematical logic could be considered as non-empirical knowledge derived directly from Reason. The philosophical plight of the average modern working mathematician is that he is a Platonist on week days and formalist on Sundays ! When he is doing mathematics he is convinced that he is dealing with an objective reality. But when challenged on the week-end to give a philosophical account of his reality he pretends that he does not believe in it. Most mathematicians are Platonists at heart until they become aware of some of the difficulties of set theory when he would rush into the shelter of Formalism! Which says that much of all pure mathematics is a meaningless game.

The delightful book by Philip J. Davis and Reuben Hersh has put together a variety of mathematical fare on a delectable 'eight-course dinner' which starts with the cocktail of mathematical landscape and through the utilitarian, the aesthetic and pedagogic aspects of mathematics, ends with the cognac of mathematical reality. For those who could afford the rather expensive dinner, it would be a memorable and revealing experience.

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E. B. Christoffel—The influence of his work on mathematics and physical sciences, Birkhauser Verlag, P.O. Box 34, CH-4010, Basel, Switzerland, 1981, pp. xv + 761, S.Fr. 92.

Nineteenth century European mathematics, dominated by Gauss and Riemann can be considered as the golden era for the queen of sciences. Gauss was the greatest of all mathematicians and perhaps the most richly gifted genius of whom there is any record. He founded the discipline of differential geometry of two dimensions and formulated the concept of Gaussian curvature. From this discovery of non-Euclidean geometry and the extended work of Riemann and Christoffel, resulted one of the deepest and most far reaching contributions in pure mathematics without which Einstein's general theory of relativity based on four-dimensional geometry of curved space-time would not have been possible. Christoffel's name has been inextricably bound with differential geometry for more than a century. It is perhaps the famous elusive Christoffel symbols; $\Gamma_{ij,k}$; Γ_{ij}^{k}; used to describe a general linear connection in a vector bundle that made the name so well known to every mathematician. The dominant contribution of Christoffel was in differential geometry leading to the important application to tensor analysis in the general theory of relativity. The use of this global geometric technique has again come into limelight in recent years through the gauge field theories that attempt at an unified geomentric theory which would encompass not only gravitational and electromagnetic forces but also all other fundamental interactions between sub-atomic particles, One can say with conviction therefore that Christoffel's ideas have finally led to the setting up of the basic laws of present day physics. If a tentative appraisal of Christoffel's work is to be undertaken, his other noteworthy contributions have to be cited. For example, only specialists would be familiar with his contribution to the general theory of conformal mapping, to numerical analysis and to the theory of special functions of mathematical physics. Even they may not be aware of the broad scope of his work. It may come as a surprise to many that among Christoffel's achievements may be found his pioneering work on the theory of hyperbolic equations, potential theory, shock-waves and continued fractions. Christoffel was often far ahead of his generation so that part of his work was not fully understood and therefore not appreciated. The first impression that one gets of Christoffel's work is that he picked up the many different and coloured threads in the fabric of science. Indeed he did research in eight different branches and directions of pure and applied mathematics. He primarily worked out the basic concepts underlying the problems he tackled so that he left abundant material for others to take up later. He confined his published work (only 35 papers) to what he personally felt was original, creative and pioneering. He seems to have thrived as a loner and did not have many students. Therefore, he did not have a school, as for example Weierstrass had. Christoffel strived to emulate his teachers like Dirichlet and Riemann. Many scholars have attempted to rank Christoffel among the mathematicians of his time in a total concept covering areas like numerical integration, invariant theory and differential geometry, potential theory and continuum mechanics, etc. He is appropriately ranked behind Gauss, Riemann, Weierstrass and Dirichlet. The present book represents the outline of the proceedings of the International Christoffel Symposium held in Aachen in 1979 which has stressed his contribution to contemporary mathematics, particularly in terms of the direct and indirect impact on modern development of mathematics, physics and mechanics. This volume would be favoured by mathematicians and theoretical physicists alike and would form part of the valuable collections of their personal library.

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Elements of statistical inference (Fifth edition). By David V. Huntsberger and Patrick Billingsley. Allyn and Bacon (Indian orders to UBS Publishers' Distributors Limited, 5, Ansari Road, Box 7015, New Delhi 110 002), 1981, pp. x + 505, £ 8·95.

This is an introductory book on statistics and hence the only prerequisite the authors assume is algebra and a little bit of calculus. This is written for college students whose major area is probability and statistics.

The book starts with an excellent introductory chapter on the study of hypertension and is very well presented. Reading the first chapter will certainly motivate the student to go deeper into the concepts of statistics. The authors then introduce descriptive statistics. The chapter on probability is concise and is relevant to the point of view of statistics. The next four chapters consist of sample and distributions, sampling distribution, estimation and listing hypothesis. These chapters form the essential basis of statistics. Then follow statistical testing about metrinomial parameters, goodness of fit, etc., followed by a good chapter on regression and correlation. In this chapter the authors discuss the least squares method, linear regression and multiple regression. The book concludes with two chapters on analysis of variance and non-parametric tests.

Bearing in mind the level of the college-entering students the authors have attempted to strike a balance between applications and theory. However, students majoring in mathematics may not find the treatment to their liking since the theoretical content is at a low level. However, in my opinion this book may be vety useful for engineering and management students who are more interested in the applicational aspects. The authors have dealt with this aspect thoroughly right from the first chapter on hypertension study to the last chapter.

There are plenty of problems for students to practice with answers to many of them. The get-up of the book is very attractive. The entire book is rather easy on the eyes. As an introductory book on statistics I find it quite good.

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Laplace transforms and applications by E. J. Watson. Van Nostrand Reinhold Company, Molly Millars Lane, Workingham, Berkshire, 1981, pp. viii + 205, £ 3·95.

This book is another addition to a long list of books on Laplace transforms. Whereas many of the other books treat Laplace transforms as part of circuit theory, this one deals with Laplace transforms exclusively. As a consequence, the author is able to do more justice to some of the complicated aspects of Laplace transform theory like solution of partial differential equations with reference to heat and wave equations, integral equations, difference equations and Fourier series and Fourier integrals. There are a number of complicated examples worked out in the body of the book. The examples are well chosen in the sense that they are application-oriented rather than mathematical-oriented. Further examples have been provided at the end of each chapter so that the reader can test his understanding of the method. Answers to selected problems have also been provided.

The earlier part of the book presents the development of Laplace transform theory and its use in the solution of ordinary differential equations. This part is conventional and is covered in any book on circuit theory. There is a good chapter on the inversion integral and quite a few examples have been presented on valuation of inversed transforms using the inversion integral.

I would have preferred the definition of the Laplace transform from O- to ∞ rather than O to ∞. The examples presented on circuit theory do not convey the difficult aspects of encountering impulse functions where the definition O- to ∞ is useful. There is no index to the book which is a drawback.

An additional bonus the author gives is a list of transforms which is quite comprehensive. On the whole the book is well written and will be useful supplement for application engineers who want to use Laplace transform techniques for solving real world problems.

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Frontiers in statistical quality control edited by H. -J. Lenz, G. B. Wetherill and P.-Th. Wilrich. Physica-Verlag, Wuerzburg-Vienna, 1981, pp. 294, DM 120.

This volume contains the revised versions of the twenty-two papers presented at an international workshop in Berlin during June 1980, which was limited to research workers who made significant contributions to the area of statistical quality control during the most recent five years or so. As the editors point out the twin difficulties concerning the research work in this area are that the papers are published in a wide variety of journals and that there is insufficient contact either among the researchers themselves or between them and the practitioners. The workshop was organised keeping these problems in view. The book serves the useful purpose of putting in one place the papers presented in the workshop, which was either in the field of sampling inspection or process control. The majority of the papers are on the former. The book has a good format and is well printed. However, some errors have crept in. For example, 'Rooming' in contents (line 12) and 'Roming' on pages 54-57 instead of 'Romig'!

The papers by Baker, Koyama, Lenz *et al.*, Liebesman, Sackrowitz, and Schilling deal with adaptive sampling plans. The matching problem is considered by Dayananda *et al.* Farlie, Hosono *et al.*, Montgomery *et al.*, Sarkadi, Kollerström *et al.*, and Saniga *et al.*, treat the non-normality case. There are six papers on optimal designs —those by Asano *et al.*, Ercan, Guenther, Kuhlmeyer, Moskowitz *et al.*, and Rinne. The inspection problem is analyzed by Collani, Menipaz and Shahani.

The volume has papers with theoretical and practical utility in varying degrees. They also greatly vary in their lengths. By and large, advances on theoretical frontiers seem to be way ahead of the applicability of the techniques, as generally is the case with any advancement of knowledge. The papers included here indicate the current patterns in the continuing research activities in the field. A list of appropriate references is given at the end of each paper.

The book should be a welcome addition to any library catering to the needs of researchers.

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Instrumental analysis edited by Henry H. Bauer, Gary D. Christian and James E. O.' Reilly. Allyn and Bacon, Inc., 1978, pp. 832 (PB), £.10·95.

There are a good number of books on instrumental methods of analysis which treat the subject-matter to different extents and depth. Considering the importance of the field one should welcome a book which treats the topics differently.

Instrumental analysis covers a wide field and it is difficult to expect any single/small group of authors to do justice to all the methods of instrumental analysis. Here is a book resulting from the contributions of a group of 27 authors. Each topic is written by one who is actively working in the field and no author is associated with more than three chapters. The editors have attempted and succeeded in maintaining uniformity in presentation.

Each chapter deals briefly with the theoretical background of the method in clear but qualitative manner, then the general instrumental requirements are discussed and finally the utility and actual application is emphasized. In selecting the methods for detailed discussion, consideration is given for the application of the method in quantitative analysis rather than the intrinsic importance of the method. This book on instrumental analysis does not contain any details of commercially available instruments or any detailed discussion on electronics and instrumentation. On the other hand, there are chapters on computers in analytical instruments and automation in analytcial chemistry. Discussions include as modern fields as ESCA and Auger spectroscopy.

The volume is intended as a textbook for a course on instrumental analysis. Each chapter has a bibliography, a list of important references, a good selection of problems and as could be expected in a textbook—answers for numerical problems. This book lacks procedures of laboratory experiments which could be useful for a practical component of the course. Probably the Editors were forced to delete this because of the size of the book which is already quite large for a single volume.

The book is well written and will be useful to students and teachers alike. It would be a good addition to any library.

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Physical chemistry by J. Philip Bromberg. Allyn and Bacon, Inc., 1980, pp. xiv + 882, (International Student Edition), £9·95.

In the author's own words, this book is designed to teach physical chemistry to the students at the mid-college level (in the U.S.). The text material is divided into seven major sections, each section carrying varying chapters. There are a total of 42 chapters and contain over 800 problems placed at the end of each chapter to support what is being explained.

The macroscopic world of classical thermodynamics is fully explained before discussing statistical and quantum mechanics. The key principles of science and a mathematical review form the introductory chapter followed by two chapters on gas laws. The next six chapters are devoted to the development of thermodynamics (First law, thermochemistry, second and Third laws). In the succeeding eight chapters, applications in chemical and phase equilibria, colligative properties and non-electrolyte solutions, electrolyte solutions and electrochemical cells are developed. The remaining two chapters in this section are devoted to the rudiments of gravitational, electrical, magnetic and surface work, and macromolecules.

The next section (five chapters) is devoted to the development of statistical mechanics approach (Maxwell-Boltzmann distribution of molecular velocities, collision and transport properties of gases and applications). The succeeding several chapters form the topics of quantum mechanics of atoms and molecules. The key mathematical development necessary to understand the terminology and qualitative argument often applied in quantum models is provided. The concepts are then applied to the discussion of chemical bonding and spectroscopy. The following section on atoms and molecules in condensed state (five chapters) deals with solid state, X-ray diffraction studies, thermal and electrical properties of solids. The final chapter in this section discusses the magnetic and electric properties including the elements of magnetic resonance spectroscopy.

In the section on chemical kinetics (reaction rate, mechanism and theoretical approaches), the emphasis is laid on how the rates are determined and the reaction mechanisms analysed. The concluding chapter of the book devoted to photochemistry is clear and informative.

There are ample diagrams and tables throughout the book. An interesting feature of this book is the sprinkling of the biographical sketches of eminent scientists interspersed throughout the text. The book, though certainly not light reading by comparison to many other physical chemistry textbooks, is easy-reading. The fundamental strength of easy readability undoubtedly will make this book a good choice for wide range of students and teachers at the M.Sc. and higher levels in the Indian universities.

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Quantitative analytical chemistry by James S. Fritz/George H. Schenk (IV Edn.), Allyn and Bacon Inc., 1979, pp. 660 (PB), £9·95.

This is the fourth edition of the book by the same title. This edition has undergone a drastic revision, reorganization in the chapters and some new additions.

The book is in two parts. The first part (25 chapters) covers the basic principles, classical chemical analysis like gravimetry, volumetry including complexometry and non-aqueous titrations, a good account of separation methods like electro-separation, extraction, different forms of chromatography and ion exchange methods. This part also includes spectrophotometric methods with a short account of other methods of spectroscopy and some electrometric methods.

The second part consists of 33 experiments—starting from the basic experiments of weighing and calibration to coulometric and amperometric titration.

This is meant as a textbook. Still it includes a chapter on analysis of real samples. Surprisingly there is no discussion on reference materials. However, the discussions are clear. The printing and get-up are good. The fact that the fourth edition has already gone for reprinting (this book under review is the second printing of IV Edition) is an evidence that the book is well received. This would be quite useful for students and teachers alike.

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First year chemistry by J. M. Coxon, J. E. Ferguson and L. F. Phillips. Edward Arnold (Publishers) Limited, 41, Bedford Square, London, WC1 B3DQ. U.K. Price £9·75.

The book, intended for the first year university course students, is a compact and concise compilation of the fundamentals of physical, inorganic and organic branches of chemistry with a trace of biochemistry too at the end. The authors should be congratulated for their sincere attempt to present, in a straight forward yet stylish manner, the essence of chemistry in a nutshell to a student who as per them, is expected to have a passing acquaintance of the basic ideas.

The first three chapters deal with the structure of matter, and the nature of chemical bonding in brief. The fourth chapter deals with a thorough discussion on the First law of thermodynamics. The Second law has been totally omitted. It would have been more appropriate if the Second law of thermodynamics was also briefly touched upon.

The next three chapters deal with physical chemistry in which basic concepts such as acid base equilibria, and chemical kinetics are dealt with. Chapters 9 to 12 are dedicated to the inorganic chemistry in which the elements are discussed as per the classification based on the modern periodic table. Chapters 13 to 18 deal with basic organic chemistry which in the opinion of this reviewer is too brief for a beginner to understand. The last chapter concerned with the biological chemistry is a vain attempt to compress the vast subject into a bare minimum of one chapter of about 15 pages with the consequence that no justice is done to any one of the topics therein. Doubtless the book is written to suit more to a particular curriculum and syllabus rather than with a motive to give a clear picture of the subject to the beginner. The teaching community should be opposed to any syllabus prescribing this kind of a conglomeration of all the branches of chemistry into one small volume. The prescription of far too less number of teaching hours to complete the entire syllabus of this general chemistry will only probably result in the production of similar textbooks which should invariably be supplemented by the detailed reference books for a student who is genuinely interested in mastering chemistry.

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