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Book Reviews

The business of living: An acquaintance with biology by Sandhya Mitra, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp. 356, Rs 150.

The book reflects a commendable effort by the author to introduce biology in a novel perspective. The author attempts to introduce indeed a wide range of concepts and scientific developments ranging from thermodynamics to molecular biology and behaviour to evolution. Dr Mitra attempts to present a good textbook which can serve as a backdrop for an introductory biology course. Though the effort is laudable, the final product falls short of expectation. The book could do with a lot of improvements particularly the early and late chapters.

The major stumbling block is lucidity. Though the titles of many sections are appealing they fail to convey what the author intends to. A good example is the first chapter itself which is supposed to give a historical survey of the evolution of major concepts in biology. Most of the chapter is irrelevant to biology. At the same time, the history of emergence of major concepts such as heredity is not given sufficient attention. The book suffers from dramatisation specially in the first two chapters. For instance, the statement (page 32) that "DNA embodies all information about the structure and development . . . DNA in an eukaryote has myriad more subtle features that are absent in prokaryotes" is rather misleading and presumptuous. This is an over-simplified interpretation of development, and in the absence of any explanation 'myriad subtle features' implied for eukaryotic DNA contradicts the recent observations which show that basic molecular mechanisms are conserved to a considerable degree among prokaryotes and eukaryotes. In an attempt to be dramatic, Dr Mitra makes innumerable factual errors. In her introduction to Dalton's atomic theory, she states "Atoms were proposed to be the ultimate discrete units of matter that could be interconverted to energy and *vice versa*" (page 19). Dalton has apparently preempted Einstein! The other disturbing pattern in the book is that of premature introduction of certain information. For instance, on page 61, the discussion on cDNA cloning can be very confusing, considering that the concepts of gene cloning themselves are introduced in a much later part of the text. This pattern is repeated in others such as Chapter 4. A glossary including the terminologies used in the text would prove useful to the reader.

The rest of the chapters read well and effectively introduce the concepts in basic biochemistry, molecular genetics, reproduction, immunology, evolution, development and neurophysiology. The presentation is a far cry from the conventional textbooks. However, it would help the reader immensely if the text is interspersed with more cartoons and illustrations. It is nice to find a list of references which will benefit interested reader.

The shortcomings of the early chapters seem to make a comeback towards the end of the book. Biology is essentially an experimental science. Major breakthroughs in biology have come from asking a fundamental question and trying to find the answer by making crucial observations and by designing simple but elegant experiments. The discovery of the principle of heredity, the laws controlling the development of a fertilised egg, the theory of evolution, and more recently, the discovery of the chemical nature of the gene all fit into this simple pattern. Dr Mitra's writings leave one with the impression that most of the excitements in modern biology stem from growth in physical sciences and technology, particularly electronics. Though this can be said about some aspects of biological analysis, the conceptual framework of biology still depends on simple and direct experiments. Even in the overemphasised field of 'recombinant DNA research', a lot can be achieved in the absence of any fancy equipment or electronic technology. Statements such as "Physicists are turning to the living system to decipher how complex reactions are carried out . . ." and "There will come a day when biology might subsume physics itself" are uncalled

for. To give the impression that a conflict exists between physicists and biologists for intellectual supremacy is as unwarranted as statements such as "Homo sapiens—the monarch of all he surveys". In the concluding chapters, one also gets the feeling that most of biology is designed for the betterment of life on earth. Any technological breakthrough that assists life is a bonus. But the biggest prize, at least as far as learning biology in schools and colleges, is knowledge itself about us and the world around us

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Medicinal chemistry by A. Kar, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp. 483, Rs 500.

The book represents a laudable effort to expose undergraduate students in developing countries to various aspects of medicinal chemistry, especially synthesis, which is not handled by too many monographs. It is also expected to be a handy reference book for professionals like practising pharmacists, medical representatives and manufacturing chemists.

The book opens with two general chapters, one on 'Drug design-a rational approach' and the second on 'Physical-chemical factors and biological activities'. The other 19 chapters deal with drugs of various types and for diverse indications ranging from general anaesthetics to antibiotics. Each chapter has three sections, consisting of introduction, classification and synthesis, the last one being fairly elaborate. Additionally useful features are the listing of international nonproprietary names (INN), British-approved names (BAN) and United States-approved names (USAN) as well as treatment dosages and occasionally, indications. A seven-page index makes referring easy

So much on the positive aspects of the book. On the negative side have to be mentioned several drawbacks, mistakes and shortcomings.

The first two chapters dealing with theoretical aspects of medicinal chemistry are poor in presentation, naive in approach and often incomprehensible: *e.g.*, p. 6, lines 6–8: 'The electronic features of the molecules responsible for chemical alterations form the basis of drug molecule phenomena' and p. 6, lines 9–11: 'Based on the assumption that electrons present in molecules seem to be directly linked with orbitals engulfing the active molecule which set forth the molecular orbital theory'.

While, generally, some of the newly developed drugs have been recorded, this is not so in the case of antihistamines (Chapter 14). The author has devoted nearly 22 pages for the description of the classical H_1-receptor antagonists like chlorpheniramine, but has not touched upon any of the modern long-acting, non-sedating drugs like astemizole and terfenadine. In the last chapter on antibiotics, the beta-lactam group must have at least a passing reference to cephalosporins.

More disturbing is the fact that there is no mention whatever of antidiabetic drugs like tolbutamide, chlorpropamide, glibenclamide and metformin nor of anthelmintic drugs like mebendazole, albendazole and pyrantel and antiamoebic drugs like metronidazole, tinidazole and diloxanide furoate. If there was a limit to the size of the volume, surely chapters like local anaesthetics and muscle-relaxants could have been abridged to offer a foothold for the missed-outs.

The flowcharts provided in abundance do serve a useful purpose in enlightening the novitiates in medicinal chemistry but become irksome with unnecessary legends like 'an acid' (p. 241) or 'an amino aldehyde' (p. 394). The latter is incidentally incorrect: the compound is a formamide! A recurring mistake in the flowcharts is designating keto-enol tautomers as 'lactam' and 'lactim' (p. 423). Mistakes also occur occasionally in structural formulae, *e.g.*, carbamazepine (p. 156)–10,11–double bond missing.

While the get-up of the book is good, the reviewer feels that flow charts could have come out darker.

Thus, for example, the structure and legend of oestradiol (p. 8) are not seen too well; and at least in the reviewer's copy, the sheet pages 5 and 6 came out of the binding though the book had not undergone much stress!

In conclusion, Kar's *Medicinal chemistry* is a useful book which institutional libraries can afford to buy. At Rs 500 it is inexpensive by international standards but somewhat beyond the reach of the less-affluent students in developing countries. It certainly requires considerable improvement to merit international acceptance.

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Biological performance of materials—Fundamentals of biocompatibility by Jonathan Black, Marcel Dekker, Inc., 270, Madison Avenue, New York 10016, 1992, pp. 390, $99.75.

This is the second edition of the book intended as a reference tool on biological performance of materials for practicing engineer as well as an undergraduate textbook on biocompatibility. It consists of 20 chapters in four parts–general consideration, material response function and degradation of materials *in vivo* host response: biological effects of implants and methods of test for biological performance. This subject has become important in view of the increased use of a variety of materials in medicine and engineering The following examples illustrate the diversity of subjects covered. Fick's law of diffusion, planned leaching for drug release, engineering variables in corrosion rates, organometallic compounds, mechanics of materials, lubrication and wear, infection, effect of implants on phagocytosis, hemolysis, immune response, foreign body carcinogenesis, iron and susceptibility to infectious disease, systemic distribution and excretion, allergic foreign body response, testing for biocompatibility, cardiovascular functional tests, design of clinical trials of the materials, safe medical devices act (1990), and selection of implant materials. Each chapter is crisp and has references at the end for further reading. This book is a good example of how an interface subject can be developed into a course.

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Lasers in chemical and biological science by S. Chopra and H.M. Chawla, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp. 199, Rs 250.

This is a monograph developed from the lectures given at the Winter School (December 1987) and Workshop (December 1988) on Lasers in Chemical and Biological Sciences held at the Indian Institute of Technology, New Delhi.

The invention of the laser more than three decades ago revolutionized the work in spectroscopy, optics, in particular nonlinear optics, and opened many new applications in chemistry and solid-state physics. The coherent properties of laser beams led to the use of lasers in holography and experiments in modern optics. Subsequently, the applications of lasers have extended from pure physics to biology, medicine, technology and new characterization techniques. The present volume is a good introduction to chosen applications in a range of topics and the fourteen chapters have been written by experts engaged in studying some or other aspects of laser applications. The editors naturally had to select the topics based

on their own personal perception and with their rich experience in certain laser applications of interdisciplinary nature they have made a good choice of the topics, which are specifically useful to chemical and biological sciences. For example, it is now widely known that lasers find extensive use in surgery but the changes in tissue of living systems and cells did not fully follow a simple picture based on vapourization and coagulation actions. Research indicates that a spectrum of effects ranging from minor nonlethal injury to cells and subcellular material to the more gross manifestation of vapourization and coagulation may coexist in the same tissue. More recently, it has been shown that the interaction may be at molecular level producing no structural variations discernible by the standing techniques of morphological studies but leading to deviations in function from the pre-irradiated state. It has been seen that cell chromosomes containing DNA may be affected with presentation as a cancer at a much later date. These observations show the need for further studies on laser tissue interaction.

The first article 'Lasers in medicine' by D.D. Kukreja gives an outline of the state of the art in the development of laser technology in India and some of the basic facts about lasers and their properties which make them useful for applications in medical sciences. The article on use of lasers in chemical reaction dynamics deals with applications in bond selective chemistry. The next article on optical holography in medicine and biology covers the basic principles and applications of this technique which range from data storage and retrieval to dentistry. K. Singh and S. Bhaskar have provided an extensive bibliography which will be found very useful. The sections on picosecond fluorescence lifetime measurements and time-resolved spectroscopy in photosynthesis and fast energy transfer processes utilizing laser pulse excitation, surface-enhanced Raman scattering, proton transfer lasers and study of surfaces by second harmonic generation deal in a selective manner the current trends in these topics and will be found useful by research workers in these fields.

The most widely applied medical lasers are the opthalmic lasers which are being extensively used in India. They are also used in the treatment of retinal detachment, vascular blocks, tumors, and glaucoma.

The chapter on changes in tissue on laser irradiation and implications in clinical practice by S.K. Guha, as indicated earlier, highlights the importance of further studies in this field.

The applications of dynamic light scattering techniques in physics, chemistry, biology, medicine and fluid mechanics have been dealt with nicely in the articles by H. Bohindar, H.M. Chawla and S. Chopra and will be found useful by research workers in these fields. The brief account of lasers in crystal growth and laser technology in studies on sperm physiology shows the potential of the use of lasers in a variety of interdisciplinary topics. As indicated by the editors there are many other applications of lasers that have not been covered in the present volume and it will be nice if the other volumes are brought out at an early date providing details in regard to instrumentation and techniques, which will be useful for those initiating work in these areas.

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Superconductivity today by T.V. Ramakrishnan and C.N.R. Rao, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp. 115, Rs 55.

The book under review is part of the educational monograph series of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) which attempts to cultivate a general appreciation of some of the frontier areas of science and engineering. The book, though addressed to senior students at graduate and post-graduate level, aims to appeal to general readers who are interested in science and technology.

The reviewer would like to comment on how far these objectives are achieved. *Superconductivity today* is written by two eminent scientists of the country, *viz.*, Profs T.V. Ramakrishnan and C.N.R. Rao of the

Indian Institute of Science, Bangalore They qualify the book as an elementary introduction to the subject.

Chapter 1 deals with the historical introduction and the phenomenon of superconductivity is dealt with in the second chapter. In fact, the second chapter completely covers all the aspects of superconductivity in a very popular way without losing the rigour. Even applied aspects of Josephson tunnelling are neatly dealt with. The reviewer would have liked some more emphasis on the superfluidity phenomenon *vis a vis* superconductivity.

The chapter on materials tries to express the entire subject spanning seventy years in about 20 pages. Naturally high T_C cuprates both in bulk and thin film forms occupy major portion of the discussion. Hence, the authors' unsurpassable expertise shows itself. The physical measurements are given in great detail in Chapter 5 along with some discussion on the electronic structure of cuprates. The authors admit that no detailed and generally accepted theory of cuprates and their superconductivity exists in spite of voluminous work in the last six years. The chapters on applications and challenges and opportunities are basically of popular nature.

The reviewer would like to congratulate the authors for presenting the subject in such a manner that both senior students and science enthusiasts would greatly benefit from this monograph.

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Physical characteristics and critical temperature of high-temperature superconductors edited by M.M. Sushchinsky, Nova Science Publishers, Inc., 6080 Jericho Turnpike, Suite 207, Commack, New York, 11725–2808, USA, 1992, pp. 227, $74.

Applications of superconductivity are limited by the fact that the superconducting state exists only at very low temperatures. Before the discovery (in 1986) of copper-oxide-based high-temperature superconductors, the highest known superconducting transition temperature was close to 25 degrees Kelvin, which is well below the boiling point of liquid nitrogen. During the last three decades, a great deal of experimental and theoretical research has gone into the development of materials which would exhibit superconductivity at relatively high temperatures. The book under review deals with this aspect of research on superconductivity. The materials considered in this book are *not* the new copper-oxide-based superconductors, some of which have transition temperatures in excess of 100 degrees Kelvin. It is concerned with more 'conventional' superconductors (in particular, niobium compounds with the A15 structure) with transition temperatures lower than 25 degrees Kelvin. The title of the book, therefore, is somewhat misleading, especially in view of the fact that it was published more than five years after the discovery of materials with much higher transition temperatures. Nevertheless, the material covered in it is useful because practical applications of the new high-T_C materials are still at the experimental stage and all the existing devices which make use of superconductivity are based on the more conventional superconductors.

This book is divided into two chapters. The first is concerned with the dependence of the transition temperature on various physical characteristics of the superconducting material. The basic mechanism of superconductivity in the materials considered here is known: it is the electron–phonon mechanism described in the classic Bardeen–Cooper–Schrieffer theory or its variants. This, however, does not mean that everything about the superconducting behaviour of these materials is understood. In particular, first-principle calculations of the transition temperature do not exist for most of these materials. In the absence of a detailed theory, the approach taken by a large number of researchers in this field has been an empirical one in which an attempt is made to discover systematic trends and correlations from existing experimental data. The usefulness of this approach towards the development of materials with high transition temperatures has not been fully established. In particular, the discovery of the new high-T_C materials did not follow

this route. Also, most researchers working in this field believe that there is a fundamental upper limit of about 40 degrees Kelvin to the transition temperature achievable from the conventional electron–phonon mechanism. Nevertheless, a study of the relationship of the transition temperature with various physical properties of the system is interesting to those working on the development of a detailed undertstanding of superconductivity in conventional 'high-T_C' materials. The first chapter of this book does a commendable job of summarizing a vast amount of existing experimental data on the systematics of the dependence of the transition temperature on nearly all conceivable physical characteristics of these systems. Theories which provide qualitative explanation of some of the correlations observed experimentally are also discussed. A summary of the observed correlations of T_C with various physical characteristics of the superconducting material is given in a table which would be useful to researchers in this field. This table also contains the author's suggestions about the values these characteristic parameters should have for achieving a T_C close to 30 degrees Kelvin. As noted by the authors themselves, the requirements for achieving this value of T_C in this class of materials are quite stringent and the development of materials with the suggested properties would be a difficult task. This chapter also contains an extensive bibliography (mostly pre-1980) of experimental and theoretical work on this subject. This would serve as a useful source of reference to people working in this field.

The second chapter deals with two A15 compounds, Nb_3Ge and Nb_3Si, which have the highest transition temperatures among the 'conventional' superconducting materials. Experimental methods of preparation of these materials and stabilization of the high-temperature superconducting phase are discussed in detail. Results of a number of experiments which measure various characteristics of the normal and superconducting phases of these materials are presented. Relationships of these materials are studied in detail and an attempt is made to correlate these properties with the mechanism of growth and stabilization of the superconducting phase. A comprehensive list of references is also provided. This chapter contains a wealth of information useful to researchers interested in the preparation and characterization of these materials and in the study of their superconducting properties.

To summarise, this book provides a fairly comprehensive review of a specialized subject whose importance has diminished substantially after the discovery of cuprate superconductors with much higher transition temperatures. However, many aspects of superconductivity in the materials considered in this book remain incompletely understood. It will be useful to researchers interested in the development of a better understanding of superconductivity in these materials.

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Interfacial transport phenomena by J.C. Slattery, Springer-Verlag GmbH & Co. KG, Postfach 105280, Tiergartenstraße 17, D-6900 Heidelberg 1, 1990, pp 1159, figs 190, DM 168(hc).

Transport processes occurring through phase boundaries have occupied the attention of engineers for quite some time and lumped transfer coefficients were so far sufficient to deal with problems arising in the analysis. The large-volume commercial applications arising out of coatings, dispersions, etc., have, however, forced engineers to examine and understand the thin interfaces in greater depth. Several books on surface chemistry have been in existence for long. Of them, only book by Rideal Davies had dealt with transport processes in interfaces, though qualitatively only. Thus the book by Slattery is an attempt to outline procedures for quantitative analysis of transport processes occurring through interfaces. The approach necessarily has to be similar to that adopted in the description of transport processes in bulk, and Slattery employs the style of his earlier book *Momentum, energy, and mass transfer in continua*.

The book thus contains an axiomatic exposition of continuum theories, in the mould of Truesdell's, of fluid mechanics of interfaces. The book assumes knowledge of basic surface chemistry.

The first chapter, after a brief description of Gibb's model as well as surface phase model, goes on to develop kinematics and laws of conservation of mass. Problems associated with moving contact lines are discussed. The second chapter develops concepts of stress to derive equations of motion of interface, and discusses models for rheological behaviour of 'surface fluids'. The third chapter applies the formalism developed thus far to discuss static equilibria, and analyses flow in a few situations. The latter include those that can be used to measure rheological properties of interfaces, drainage and instability of thin fluid films, and moving contact lines. The fourth chapter deals with integral balances and includes application of variational principles. Very little work has appeared along these lines and perhaps this work will act as a catalyst. The fifth chapter goes into multicomponent systems and the necessary thermodynamic framework. The equations of differential balances are then set out. The sixth chapter uses these equations to solve problems involving simultaneous energy, mass and momentum transfer. Included here are problems of motion of drops and bubbles under the influence of surface tension gradients created by either gradients in temperature or concentration of surfactant. The book ends with a discussion of integral balances.

The book is written with clarity and in an informal style. A large number of tables giving the various equations, in the commonly used coordinate description of interfaces, are presented. These will be of immense value in setting up a variety of problems, and will prove, in convenience, to be the equivalent of tables of Navier–Stokes and other transport equations in the three commonly used coordinate systems For this reason alone, if nothing else, this book should be on the shelves of every library. No book can be perfect and to the liking of one and all. The book is a reproduction of a typed version and not set to print. As a result it is bulky and I found the appearance of equations deterring. I also feel that the axiomatic approach taken, though elegant, does not allow enough emphasis to be placed on the physics of the phenomenon. Formalism eats up space that could have been devoted to more examples which give more of a learning experience to engineering students. This aspect will come in the way of its popularity despite the appropriate timing of its appearance.

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Geometric and physical optics by P.K. Chakrabarti, New Central Book Agency Pvt Ltd, 8/1, Chintamoni Das Lane, Calcutta 700 009, 1992, pp. 345, Rs 100.

The book written by Dr Chakrabarti of St Xavier's College, Calcutta, is an excellent introductory textbook of optics at the undergraduate or bachelor's (B.Sc., B.Tech., B.E.) level. The material covered is extensive delving into the principles of numerous *classical* optical elements and instruments based on them, the emphasis being on the more commonly used devices. Most of the chapters are concise and could form the basis of one or two lectures that are reasonably self contained. Each chapter has a set of solved and unsolved problems which may be used to extend the students grasp of the ideas enunciated. One may say that this book represents a modern precis of Born and Wolf's *Principles of optics*. There are a few minor typographic and labeling errors that may be corrected in future editions.

The first half of the book deals with the ray or geometric optics approach. Chapter II introduces matrix formulation of geometric optics. The reader must be cautioned that he is expected to be familiar with elementary ray tracing techniques and the imaging formulae. Chapter III introduces the Fermat's principle and subsequent chapters in the first half of the book deal with applications of the above two methods in solving the various problems. Refraction at plane and spherical surfaces, thin and thick lens systems are some of the topics discussed from the above two viewpoints.

The chapter on abberrations is in reasonable detail and deals with practical concepts on how to reduce each type of 3rd-order aberration. The author discusses various techniques of minimizing aberration in the optical telescope and microscope.

Part II of the book deals with physical optics. Elementary wave theory is introduced followed by rederivation of the lens formula from the Huygen's principle. The conditions for the phenomena of interference are laid out with coherence emphasized as a basic need for an interference pattern. Some of the other listed conditions for the observation of interference are too strong. Interference due to reflections from surfaces are discussed. In this context the Fabry Perot etalon is introduced. The formation of Newton's rings and its use in calculating the radius of curvature of a surface is discussed in detail.

Chapter 5 of Part II discusses diffraction. Both far and near field effects are discussed and the phenomena of far field diffraction is viewed as the Fourier transform of the slit function or aperture. The theory of the amplitude grating is discussed next which is followed by the circular grating. The comparison of the Fresnel zone plate and a convex lens is followed by section devoted to Fresnel diffraction from straight edges, narrow slits and circular apertures.

The chapter on the electromagnetic theory of light is isolated from the rest of the book and may well be omitted in view of the fact that the rest of the book follows a different methodology. The resolving power of a grating, microscope or telescope is discussed in terms of the Rayleigh criterion. This is based on the principle that the diffraction pattern of two objects or sources must result in an observable dip or change in the resulting pattern. Interferometric instruments like the Michelson's interferometer, Fabry Perot and Lummer–Gehrcke plate are also discussed.

The matrix theory of polarized light follows the chapter on interferometers. In this chapter, a brief introduction to various polarizing optical elements is presented. A short review of optical activity, rotatory dispersion and the Faraday effect is given in the chapter following. The final chapter gives an extremely brief introduction to modern optics, namely, laser and fiber optics.

In summary, the book under review, gives an excellent introduction to classical optical elements and instrumentation. Most of the commonly encountered instruments and lens combinations are discussed in detail. The approach followed is to present lenses and other refractive and reflective optical elements using rectilinear propagation in the first part. The Huygen's principle is used in discussing the interferometric devices in the second part.

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Mathematics in chemistry–An introduction to modern methods by Harry G. Hecht, Prentice-Hall, Englewood Cliffs, NJ 07632, USA, 1990, pp. 357, $75.90.

Chemistry, with its expanding frontiers overlapping with biology and materials science, attracts and accommodates students with diverse backgrounds. A course for a semester or two on basic mathematical methods and computer programming is now recognised to be essential for students to cope with the quantitative rigour involved in much of chemical research. Several books on mathematics for chemists are available. These generally fall into two categories. The classic ones, some of which are standard reference texts, provide a comprehensive coverage of mathematics and statistics. Such books read like typical mathematical treatises, with chemical applications appearing infrequently and intrusively. Chemistry students rarely read them by choice. A second category of books make breezy reading but do not cover sufficient variety of topics. Invariably, these books are written for budding quantum chemists with a heavy emphasis on second-order differential equations and matrix algebra. *Mathematics in chemistry* by H.G. Hecht makes a fresh attempt at providing a wide-ranging coverage of methods useful to chemists in a highly readable form. Computer programming using BASIC language is also included.

The book is fairly large, with five chapters, 13 appendices and numerous exercises. The first chapter is an introduction to basic mathematical concepts. The coverage begins at an elementary level with definitions

of polynomials, trigonometric functions, logorithm, exponentials, etc. Properties of complex numbers, vectors, and matrices are briefly discussed. Topics like differential and integral calculus, as well as differential equations are covered. The general approach is sensible. A concept such as integration is defined, given geometric meaning, worked out with a couple of examples, and reference provided for obtaining more detailed information. Most importantly, an attempt is made to solve chemical problems each time a mathematical concept is introduced. For example, the ideal radius ratio needed for a given coordination geometry in an ionic solid is derived after defining elementary trigonometric functions. I wish more such problems from general chemistry had been chosen. By and large, the majority of problems are from thermodynamics. Further, the author has not managed to sustain his efforts at providing chemical applications throughout. For example, the use of the Taylor expansion is illustrated with the calculation of the square root of 0·9, and not with any chemical application.

The second chapter provides a simple, straight-forward account of the BASIC language. While FORTRAN may be the more commonly used programming language for chemists, the author justifies his choice well. He just does not want to get bogged down by FORMAT statements. Therefore, the section on computer programming is crisp and certainly good enough as an introduction.

Numerical techniques are presented in the third chapter. All the standard procedures for interpolation, deriving roots of equations, differentiation and integration (including the Monte Carlo method for the latter), matrix inversion and diagonalisation, and solving differential equations are described. Using simple notations, the basic algorithms commonly employed are provided. There are no detailed proofs nor any technical discussion of errors involved. However, the merits and limitations of the algorithms are pointed out.

A lucid chapter on statistical methods follows. Not surprisingly, most of the applications are in the area of analytical chemistry.

The final chapter on some special topics allows some flexibility to the author to widen the appeal of this book. Optimization methods like the Simplex and the Steepest Descent algorithms are described. I wish a couple of more procedures had been included. Somewhat surprisingly, the least-squares method makes its appearance as a special topic. Classic applications in physical organic chemistry would have added to the appeal of this section. Numerical and programming techniques of great interest to experimentalists, *viz.*, smoothing of data and deconvolution of composite curves as well as transform techniques are covered. Basic concepts involved in chemical graph theory, pattern recognition and artificial intelligence are briefly mentioned.

The book has useful appendices. A large number of problems are worked out in the text. Numerous exercises are also included, with solutions for many of them. However, the range of chemical applications covered by these problems could have been wider.

Overall, I would unhesitatingly recommend the use of this book by teachers and students as a good introduction and a quick guide to many of the mathematical techniques widely used in chemistry.

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Stochastic analysis and applications, Proceedings of the 1989 Lisbon Conference, edited by A.B. Cruzeiro and J.C. Zambrini, Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp. 208, SFR 86. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110 017.

This is a volume of thirteen papers contributed by several distinguished mathematicians to the topic of

modern stochastic analysis and its role in the fields of Markov processes, geometry and quantum mechanics. Each contribution is a snapshot of some new results with a very brief sketch of proofs (by some of the authors) and a useful bibliography. It is more useful for the cognoscenti than for a beginning graduate student. In the Indian universities and institutes with very little opportunity for an encounter with the great recent developments in the field of stochastic processes and its influence on geometry and quantum theory this volume has a very small probability of being issued out by a library. With these general remarks we proceed to comment on some of the individual contributions.

Albeverio, Iwata and Kolsrud discuss stochastic differential equations of the form

$$\frac{1}{2}\left(\frac{\delta}{\delta x} + i\frac{\delta}{\delta y}\right) A = F$$

where $A = A(z)$ is an unknown random field in the complex plane and F, a white noise-point process driven by a fixed Lévy measure. Choices for F, *i.e.*, the Lévy measure leading to conformally invariant solution A are presented. There is a brief mention of a similar problem when the complex variable z is replaced by a quaternionic variable.

Albeverio and Ma deal with symmetric Markov semigroups $P_t = e^{tA}$ where the generator A is determined by a singular Dirichlet from ϵ through the relation $(\sqrt{-A}u, \sqrt{-A}v) = \epsilon(u, v)$ on the domain of $\sqrt{-A}$. The main concern is existence of solutions. Bakry's paper is devoted to similar Markov processes and associated log-Sobolev inequalities. If the Dirichlet form ϵ is given by $\epsilon(f,f) = \int|\nabla f|^2 d\mu$ where μ is the canonical measure on a smooth compact Riemannian manifold and $|\nabla f|$ is the length of the gradient of f in the Riemannian metric, then the transition probability density $p_t(x, y)$ satisfies the estimate

$$p_t(x,y) \leqslant c(n)\, t^{-n}\, e^{-\frac{d^2(x,y)}{4t}},$$

n being the dimension of the manifold and d the geodesic distance. This estimate is a consequence of the log-Sobolev inequalities.

There is a similarity in flavour between the contributions of Bakry in continuous time and of Saloffe–Coste in discrete time. Here is a sample from Saloffe–Coste. Suppose $\{G, dy\}$ is a unimodular group of polynomial growth, *i.e.*, its volume measure $|\cdot|$ satisfies

$$C^{-1} \leqslant \frac{|\Omega^n|}{D^n} \leqslant C$$

for some positive constants C and D and positive integer n. Let $p(x, y)$ be a symmetric Markov kernel such that

$$\operatorname*{supp}_{x,y} p(x, y) < \infty,\ \inf\{p(x, y),\ y^{-1}x \in U\} > 0,$$

U an open generating neighbourhood of e. Then,

$$\operatorname*{supp}_{x,y} p^{(m)}(x,y) \leqslant cm^{-D/2},\ m \in \mathbb{N}^*,$$

where $p^{(m)}$ is the m-fold composition of p. This is a generalisation of the work of Varopoulos. The tools are Sobolev inequalities.

Arede in her contribution presents very pretty and explicit expressions for the transition probability densities for Markov processes, in the cases of compact and nilpotent Lie groups with Laplace–Beltrami operator as generator. It is based on the Elworthy–Truman formula for the Riemannian Brownian bridge.

Since Feynman integrals continue to outwit the mathematicians the subject gets bottled up in the more probabilistic framework of Euclidean quantum mechanics. Curzeiro and Zambrini and Kolsrud and Zambrini give a brief outline of their work ending with Nelson's stochastic mechanics. At this stage one continues to wonder whether the notion of the spin observable in quantum mechanics can really arise in some way through diffusion processes and stochastic differential equations.

Malliavin shows that simple generalizations of the Cameron–Martin quasi-invariance properties of Wiener measure cannot hold when the underlying vector fields do not commute with each other. Suppose G is a noncompact Lie group, $\{e_k\}$ an orthonormal basis for its Lie algebra in some Euclidean metric and $\{\delta_k\}$ the corresponding left-invariant vector fields, $\Delta = \frac{1}{2}\Sigma\delta_k^2$, P, the Wiener measure associated with Δ, $u(t) \in \mathcal{G}$, $0 \leq t \leq 1$, $\int_0^1 \|u(\tau)\|_{\mathcal{G}}^2 \, d\tau < \infty$ then there need not exist a function K_u such that

$$\frac{d}{d\varepsilon}\int \psi(\gamma \exp \varepsilon u) dP(\gamma)|_{\varepsilon=0} = \int \psi(\gamma) K_u(\gamma) dP(\gamma).$$

This leads to many new problems in Malliavin's quasi-sure analysis in infinite dimensions.

Nualart and Pardoux present a summary of their well-known work on the role of stochastic integrals with anticipating integrands in the solution of stochastic differential equations with boundary conditions.

Anderson and Peters discuss the problem of geometric quantization by exploiting Shigekawa's De Rham–Hodge–Kodaira decomposition on abstract Wiener spaces whereas Getzler emphasizes the role of Brownian motion in Witten's topological quantum field theory. The volume concludes with a note on the application of Varadhan's large deviation principle to the study of Gibb's states for one-dimensional lattice gases.

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Introduction to complex analytic geometry by S. Lojasiewicz, Birkhauser Verlag AG, Ringstrasse, 39, CH-4106, Therwil, Switzerland, 1991, pp. 537, SFr 168.

This book is a leisurely account of the most basic results of complex analytic geometry by an author who has made many important contributions to the subject. Roughly speaking, complex analytic geometry studies spaces which are 'locally' the sets of common zeros of finitely many complex-analytic functions (*i.e.*, convergent power-series) in several complex variables, as well as 'complex analytic' maps between such spaces. Complex algebraic geometry is thus a very important special case of the subject and much of the work in each subject has been stimulated by the other.

The present book concentrates mainly on the local and geometric aspects of the subject, and has no overlap with the books (like those of Hormander and S. Kranz) which consider the analytical aspects of function theory in several variables. In comparison with earlier similar books (by R Narasimhan, M. Herve, Grauert–Remmert, parts of Gunning–Rossi, Whitney, etc.), it is more user-friendy. As the author himself observes, his book is fairly close in spirit to Whitney's book *Complex analytic varieties*.

The first 130 pages of this 500-page book cover, in three chapters, the preliminaries needed from algebra, topology and complex analysis. In the next two hundred pages, all the basic local results of the theory, including the normalisation theorem, the Remmert–Stein theorem and the proper-mapping theorem of Remmert, are treated in a systematic way. The long last chapter, which forms the rest of the book, is probably the most novel part of the book. It is devoted to the interplay between algebraic and analytic geometry mentioned earlier. It is shown how the local study of analytic varieties parallels the study of affine algebraic varieties (Weirstrass Preparation theorem $\leftrightarrow$ Noether Normalisation), and many basic results of algebraic geometry (like Chevalley's theorem) are treated in some detail. Of course, Chow's theorem on the algebraicity of analytic varieties in projective space and Serre's 'GAGA' principle are also

covered, as well as meromorphic functions, blowing up, etc In fact, this chapter is a good introduction to complex analytic and algebraic geometry.

The size of the book is explained by the author's aim to be self-contained and easily understandable, and the book can be strongly recommended to beginners.

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Analytical geometry of two and three dimensions and vector analysis by Ratan Mohan Khan, New Central Book Agency, 8/1, Chintamani Das Lane, Calcutta 700 009, India, 1991, pp. 538, Rs 75.

Although the origins of analytical geometry go back to the works of the ancient mathematicians, in particular, Appollonius (3–2 century BC), the year 1637, which saw the publication of *Geometrie* by Rene Descartes, is taken to be the date of birth of analytical geometry. Since then, there emerged innumerable books on analytical geometry, both elementary and advanced, in the literature. The book under review is another addition to the long list of such books available in Indian market on elementary analytical geometry and vector analysis. The presentation of the subject in the book indicates that the author took the task just to design a book to cover the syllabi of Honours and technical courses in most of the Indian universities and therefore it does not contain suitable introduction or motivation to provide the reader with any insight into the topics.

The book is divided mainly into three parts. Part I covers analytical geometry of two dimensions and the contents thereof, are arranged in nine chapters, and it encompasses equations of various two-dimensional objects such as straight lines, circles, parabola, hyperbola, pair of straight lines, system of circles, etc. In Chapter 9, polar coordinate system is introduced and important equations are derived in terms of polar coordinates. Part II deals with analytical geometry of three dimensions, and is subdivided into 12 chapters. Equations of plane, quadratic surfaces (sphere, cylinder, cone), surface of revolution, conoids, tangent, normal, enveloping cone, pole and polar, and system of spheres are derived in the first eleven chapters. Chapter 12 deals with cylindrical and spherical coordinates. Part III is an introductory exposition of vector algebra and vector analysis. It has four chapters which include applications of vector methods in geometry and mechanics, Divergence theorem, Green's theorem, Stokes theorem, etc.

The basic operations of vector analysis in curvilinear coordinates received no attention in the book, though spherical and cylindrical coordinate systems are well explained in Part II. Although the major theorems (*viz.*, Gauss theorem, Green's theorem, Stokes theorem) for vector field are proved in Part III, nothing is said about the potentiality of vector field, which is, of course, of much use in application. In Chapter 4 of Part III, some notions of differential geometry are introduced; the reviewer feels that it would have been useful if a separate section/chapter on the basics of differential geometry had been added in it, which, in fact, is included in the syllabi of the undergraduate courses of most Indian universities.

Another shortcoming of the book is that it provides neither a bibliography nor an index. The list of contents is also very brief and it should have been made in more detailed form to ease the reader for prompt location of topics (For example, see the list of contents of *Analytical solid geometry* by Shanthi Narayan, S. Chand and Co., New Delhi, 1985). The book is also not free from printer's errors. The following are a few examples, (where page no., line no. and correct form are given). 4(25) "... $x^2 + y^2 = a^2$ is the locus..."; 7(32) "7(*a*)(*i*)-1/2"; 10(31) "... $a_1 / a_2 = b_1 / b_2$, *i.e.*, $a_1b_2 - a_2b_1 = 0$"; 20(7)"$mx - ly + k = 0$"; 32(5)" the equations of directrices are $x = \pm ale$"; 35(29) "... between $(-a, a)$, y is imaginary"; 496(22) "...$\Delta\vec{u}.\Delta\vec{v}$". The running title on every page of Part I is wrong; it should be "Analytical geometry of two dimensions".

In summary, the book is quite readable and provides numerous worked-out examples and exercises (with answers) in each chapter. The important notes and equations enclosed in rectangles will help the students to trace them. Although this book is not indispensable for libraries, undergraduate students of Indian universities would find it useful for their examination needs.

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Tata lectures on Theta III by David Mumford *et al*, Birkhauser Verlag AG, Klosterberg 23, CH-4010, Basel, Switzerland, 1991, pp. 240, SFr 78.

The theta function came into prominence in the 19th century in the work of Jacobi who based all of the theory of elliptic functions on its properties. Earlier in the 18th century the theta function had appeared in a different connection in the work of Euler and still earlier in the work of Johann Bernoulli. After the fundamental investigations of Riemann and Weirstrass the theory was decisively advanced by Frobenius and Poincaré. The creation of this theory may safely be regarded as one of the most significant accomplishments of the 19th century[1]. That the theta function still attracts the serious attention of mathematicians–number theorists, algebraic geometers and theoretical physicists–is clear from the large number of papers on it being written even now. The book under review is the last part of a three-volume treatise on the theta functions. This treatise certainly represents a very important landmark in the development of the subject. These three volumes originated in a course of lectures on the theta function given by the author at the Tata Institute of Fundamental Research, Bombay, in 1978–79. After discussing different ways of interpreting theta functions in the first two volumes, Mumford in this third volume clarifies the interrelations between these different viewpoints showing in particular how the Heisenberg group runs through the theory as a unifying thread. Another important contribution of the third volume is a simple explicit treatment of the algebraic definition of the theta function.

To Jacobi and other mathematicians of the 19th century theta functions were holomorphic functions of two variables–z in the upper half plane and s in the complex plane–satisfying certain transformation rules. The theta function was used by them to study elliptic functions.

The theta function made its appearence in algebraic geometry when Riemann used theta functions to embed the torus (complex plane modulo a lattice) in complex projective 3-space. In fact, this provided motivation for the study of theta functions in several variables. This led to the interpretation of theta functions as sections of line bundles on abelian varieties.

The idea of treating theta functions as matrix coefficients of representations of certain groups is due to Andre Weil in his classic paper[2]. This intepretation has proved very fruitful in unifying the different viewpoints discussed above, especially after the introduction of the Heisenberg group. Also this leads to a purely algebraic theory of theta functions.

After discussing the necessary material from the theory of Heisenberg group and its representation in the classical or real situation and in the finite/adelic or algebraic situation in the first four sections, the fifth section gives a simple explicit treatment of the algebraic definition of the theta function.

Chapter 6 deals with theta functions associated to positive definite quadratic forms. A study of the algebra of the full family of theta functions associated to quadratic forms leads to many interesting theta relations of which the Riemann's theta relation is the most typical example.

The theta relations have elegant formulations in terms of the Heisenberg group and this is the content of Chapter 7.

In Chapter 8 the full functional equation of the theta function is derived using the representation theoretic interpretation of theta function in terms of the metaplectic group and the Heisenberg group.

Chapter 9 deals with yet another natural and important generalisation of the theta function, namely, theta function with spherical harmonics. This yields still more modular forms given by the theta series. This section concludes with a few very interesting open questions concerning the image and the kernel of the Weil map.

The concluding section, Chapter 10, gives an interesting application of the theory of theta functions in determining the whole algebra of the equations defining the abelian varieties.

The price of the book is SFr 78 but no price (or praise!) is too high, for the book along with the first two volumes is worth its weight in gold.

A combined index for the three volumes and a list of notations would be very useful and we hope this fact will be kept in mind while bringing out future editions/reprints of these volumes.

References

1 SIEGEL, C. L *Topics in complex function theory*, Vol. 2, Wiley Classic edition

2 WEIL, A Sur certain groupes d'opefateurs unitaries, *Acta Math* , 1964, **111**, 143–211.

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Perspectives on the history of mathematical logic edited by Thomas Drucker, Birkhauser Verlag AG, Klosterberg 23, CH-4010, Basel, Switzerland, 1990, pp. 284, SFr 108.

The objective of history of science in general and history of logic in particular is to bring to light the nature and development of the activites of the field. Such a study helps to identify tools and techniques required to carry out activities. Also, it helps to understand and appreciate the efforts of the predecessors in the light of the current state of the field so that quick steps can be taken to reach the distant goal. Another aspect is that journals and books tend to report success stories. But it is very important from the point of view of researchers to also know the failure paths. History of a field can attempt to fill in this gap so that researchers can be provided with all the relevant information. Another aspect is that history of a field sheds light on the role of group in achieving results there by, wherever possible, eliminating the possibility of hero-worshipping.

The book has met most of the above objectives. Various chapters of the book help identify the environments that played a positive role in the progress of mathematical logic. Also, several chapters attempt to provide a critical analysis of the foundational works. As a result, the book forms a useful study material not only for researchers working in the area of logic but also to those who use logic. The book attempts to "...[bind] together a community of contributions rather than leaving the impression of isolated wonder-workers." This will have a great influence on the young and next generation scientists as this makes clear the fact that every one has a role to play in the advancement of a field.

Some of the chapters of the book provide justification to 'hero-worship'. Unchecked 'induced hero-worship' may portray a framework of a subject ignoring the works of the contemporaries. The chapters of the book shed more light on towering personalities such as Godel, Kleene, Curry, and Buche whose contributions have spanned over many decades. The chapters by Dawson and Hao Wang, related to Godel, provide more insight into his work and personality. The chapter by Seldin describes the work of Curry while the chapter by Siefkes describes the work of Buche. Peirce's work related to algebra is described in the chapter by Houser. Some of the chapters identify the foundational aspects of the current fields of study. The way the field of automated theorem proving has been benefited by *Principia Mathematica* is described in a chapter by O'Leary. Similarly, the chapter by Siefkes describes the usefulness of logic in other disciplines. The chapter by Ruitenburg provides a critical analysis of intuitionistic

logic. The chapter by Anellis describes various issues of proof theory. Some of the chapters describe environments that prevailed when some breakthrough results were achieved. The chapter by Aspray describes the growth of logic at Princeton. Such details are of paramount importance as they suggest the kind of environments that can yield good results.

Thomas Drucker has done a good job in putting together chapters written by different authors. Summarizing, this book must be of interest to many diverse groups of students and teachers. It would make a delightful reading as it sheds light on both history and foundational aspects of various topics in mathematical logic so as to remove any lingering doubt about the topics in the minds of the readers.

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Elements of KK-theory by Kjeld Knudsen Jensen and Klaus Thomsen, Birkhauser Verlag AG, Klosterberg 23, CH-4010, Basel, Switzerland, 1991, pp. 250, SFr 98.

K-theory for operator algebras has become an extremely important tool in the theory of operator algebras during the past twenty years. Since its first use in the classification of the so-called AF (or approximately finite) C*-algebras, it has come a long way with applications ranging from the study of extensions of C*-algebras (à la Brown–Douglas–Fillmore) and the Atiyah–Singer Index theorem to foliations and the Novikov conjecture (à la Alain Connes). One of the most powerful recent tools in the K-theory has been the approach of G G. Kasparov which yields a bivariant functor $KK(A,B)$ of C*-algebras, which was motivated by an attempt to unify classical K-theory and K-homology (taking a cue from the Atiyah–Singer Index theorem for elliptic differential operators). The book under review is a very commendable attempt (by an active researcher in the area) at presenting the basic aspects of Kasparov's KK-theory to the uninitiated. Unlike other existing literature on the subject, this book contains a lot of details which the hard-working reader will be most grateful for. (As a matter of fact, in its preliminary version, the authors had used the title *Getting started with KK-theory*, which is really the philosophy behind the book.)

What follows is a brief sketch of the contents of the book.

The first chapter is devoted to a discussion of Hilbert C*-modules; here they introduce the multiplier algebra (not by its usual definition, but by an equivalent one which is natural in this setting), and prove the basic Kasparov stabilisation lemma; then they discuss graded C*-algebras and extend the earlier results to the graded setting.

The second chapter is devoted to Kasparov's original approach to KK-theory. After preliminaries on Kasparov A-B bimodules (with A,B σ-unital C*-algebras), they define the abelian groups $KK(A,B)$, show that $KK(\cdot,\cdot)$ is a bifunctor (covariant in the first argument and contravariant in the second), and carefully prove the existence of the Kasparov product (which is a bilinear pairing $KK(A,B) \times KK(B,C) \to KK(A,C)$) and derive its fundamental properties.

The third chapter discusses extensions of C*-algebras: after proving the basic fact concerning the Busby invariant of an extension, they define the abelian semi-group Ext (A,B), derive the relation between invertible elements of Ext (A,B) and completely positive contractions from A to $M(B)/B$ and finally establish the relation between $\mathrm{Ext}^{-1}(A,B)$– the group of units in $\mathrm{Ext}(A,B)$– and KK-theory.

In the fourth chapter, the authors discuss Kasparov groups for ungraded C*-algebras and prove the split-exactness of the bifunctor, and derive an abstract characterisation of the Kasparov product.

In the final chapter, the authors present Cuntz's elegant approach to KK-theory; they define $KK_c(A,B)$ to be $[qA, K \otimes B]$, the abelian group of homotopy classes of *-homomorphisms from qA to $K \otimes B$ (where: (i) qA is the closed two-sided ideal generated by $\{i(a)-j(a): a \in A\}$ in the free-product $QA = A*A$, where

i and j are the canonical embeddings of A into QA, and (ii) K denotes the C*-algebra of compact operators on a separable Hilbert space). They show that $KK_c(A,B) \cong KK_c(A, qB)$, and finally (use the abstract characterisation of Kasparov products proved earlier to) show that $KK_c(A,\cdot)$ is a universal covariant functor which is stable, homotopy invariant and split exact, and deduce that $KK_c(A,B) \cong KK^0(A,B)$ (where $KK^0(A,B)$ is just $KK(A,B)$, with A and B viewed as trivially graded C*-algebras).

This book is found to be very useful to any one wishing to learn the rudiments of KK-theory. Of course, such a reader must be prepared to roll up his sleeves and do a lot of hard work to digest the wealth of material in the book; the point is that he would have to work much harder if he were to use almost any other book on the subject.

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V. S. SUNDER

Riemannian geometry by Manfredo Perdigao do Carmo, Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp. 300, SFR 78. Indian orders to Springer Books (India) Pvt Ltd, 6, Community Centre, Panchsheel Park, New Delhi 110 017.

If one wants to give a course on differential geometry at graduate level or to students who might have learnt a bit of classical Gauss theory of surfaces one is always faced with the problem of choosing the treatment of the subject.

There are traditionally two approaches to modern differential geometry. One is to build up enough machinery to define (Ehressmann) connections on principal fibre bundles and the other is to use Koszul connection after a brief introduction to differential manifolds.

In the former, one needs to introduce, besides the foundation of differential manifolds, concepts such as Lie groups, Lie algebra-valued differential forms, etc. This approach is taken, for instance, by Nomizu's lovely little book[1], Kobayashi-Nomizu's two volumes[2] and Bishop–Crittenden[3]. This is the approach very much fancied in sixties. While the treatment is most modern, it takes quite a bit of time for a reader to get into results which can be said to belong to the realm of differential geometry.

In the latter approach, immediately after the foundations are laid, one is ready to learn the subject proper. Books by Helgason[4], Hicks[5], Gromoll–Kllingenberg–Meyer[6] [GKM] develop the subject this way. Of these, GKM has turned out to be the Bible for workers in Riemannian geometry. The book of Cheeger–Ebin[7] arose probably out of an attempt to provide a book in English. It assumes knowledge of differential manifolds and covers most of the material in GKM and also the then recent results in non-positively and non-negatively curved manifolds. However, its terse style makes it difficult reading, especially for a begineer.

The book under review, which is an English translation of the second edition of a book in Portuguese, develops the subject the second way.

In Chapter 0, the author introduces the reader to the basic concepts of differential manifolds in about 34 pages.

The book treats the basics of Riemannian geometry in a highly readable and enjoyable manner in Chapters 1–4, 6–8. The second level of the subject, *viz.*, Jacobi fields, calculus of variations of the energy of length, comparison theorem of Rauch, Rauch-Berger are treated in Chapters 5, 9 and 10. The fact that the Rauch comparison for surface is nothing other than Sturm comparison theorem is brought out in an exercise.

In early eighties, M. Gromov has suggested how the comparison theorems of Riemannian geometry which at the outset look like analytic result can be made more geometric. More precisely, various comparison

theorems follow from the study of rate of change of the second fundamental form of the hypersurfaces. do Carmo makes reference to Eschenburg[8] where this approach is worked out in detail.

The book contains a good collection of results which are perhaps not so well known but, however, illustrate the typical use of the results proved. For instance, he proves Synge–Weinstein's result on fixed points of an isometry of a positively curved manifold (Theorem 9.3.7) and Moore's result on isometric immersion (Theorem 10.3.1).

Chapter 11 gives a proof of Morse index theorem following Milnor. In Chapter 12, Preissmann–Byers results on the fundamental group of negatively curved manifold are proved. The most beautiful theorem of global differential geometry is the Sphere theorem which says that a compact, simply connected manifold with $0 < K_{\max} < K \leq K_{\max}$, with $\alpha = 1/4$ is homeomorphic to a sphere. The crucial fact for a proof of this result is the so-called Berger's lemma which is usually proved using Toponogov's theorem. do Carmo avoids Toponogov by giving Tsukamoto's proof of Berger's lemma. The proof of Sphere theorem uses elements of Morse theory. But, however, if the reader restricts himself to the even dimensional case, the proof is self-contained.

There is only one serious omission, *viz.*, the Toponogov's theorem. This result is a global version of Rauch comparison theorem and is a very powerful tool in questions of global differential geometry. I hope this result will be included in a later edition.

All in all, this book is superb in its mode of treatment, choice of topics and exposition. The book is replete with a good selection of exercises most of which are provided with copious hints. The exercises most often contain a wealth of information such as examples, extensions and material which put things in perspective. While the notes at the beginning of a chapter informs the reader about the origin and development of the concepts to be introduced, those at the end tell of new developments. The translation is very good.

Either for self-study or for a one-year course with an addition of a few more topics this book is excellent. Every library must have a copy on its shelves.

I would like to end the review with a personal note. All through my perusal of this volume, I had a sense of *déja vu*. When I thought of organizing an Instructional Conference on Riemannian geometry in 1988–89, I could not find a suitable book which reflected the recent advances in the subject and decided to write a set of notes in the form of a book. The preliminary version of this book was distributed to the participants. The choice of the material, treatment, etc., come quite close to the book by do Carmo. However, my book contains a simple proof of Toponogov's theorem and illustrates Bochner technique which is ubiquitous and proves to be the legendary phoenix in the analytical aspects of the subject.

References

1. NOMIZU, K. — *Lie Groups and differential geometry*, Vol. 2, 1956, Mathematical Society of Japan.
2. KOBAYASHI, S. AND NOMIZU, K. — *Foundations of differential geometry*, Vols I (1963) and II (1969), Wiley.
3. BISHOP, R. J. AND CRITTENDEN, R. L. — *Geometry of manifolds*, 1964, Academic Press.
4. HELGASON, S. — *Differential geometry and symmetric spaces*, 1962, Academic Press
5. HICKS, N. H. — *Notes on differential geometry*, 1965, von Nostrand
6. GROMOLL, D–KLINGENBERG–W. AND MAYER, W. — *Riemannsche geometrie in Grossen*, Lecture Notes in Math. No 55, 1968, Springer-Verlag.
7. ESCHENBURG, J.-H. — Comparison theorems and hypersurfaces, *Ms Math.*, 1987, **59**, 295-323.
8. CHEEGER, J. AND EBIN, D. G. — *Comparison theorems in Riemannian geometry*, 1975, North Holland and American Elsevier.

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Numerical analysis by Kalyan Mukherjee, New Central Book Agency Pvt Ltd, 8/1, Chintamoni Das Lane, Calcutta 700 009, 1990, pp. 299, Rs 50.

This book contains 16 chapters of elementary and basic topics in numerical analysis running through three hundred pages. Material covered in this book is quite classical and can be found in earlier classics such as *Numerical mathematical analysis* by J. C. Scarborough.

Chapters in this volume are devoted to the following topics: Round-off error and consequences, Interpolation of functions, Numerical differentiation, Resolution of ordinary differential equations by finite difference method and resolution of difference equations, Resolution of systems of linear and nonlinear equations, Summation of series using the algebra of finite difference operators, Random properties of error in measurements.

One quick look at the above list will reveal that the book covers the syllabi of Indian universities for Honours. The book may be read by students with elementary knowledge. Prerequisites to understand the volume are kept to a minimum level. Various methods are presented very clearly along with the underlying principles. Motivating examples are thrown liberally all over the text This will definitely help the student a lot in their comprehension of the methods Another positive aspect of the book is the huge collection of carefully chosen exercises with solutions and hints at the end of each chapter. Figures are also provided to explain the geometrical significance, if any, of the method.

The experience of the author in this field is vividly clear in the handling of various topics. He has also acknowledged to have freely consulted well-known volumes in this area. This book is intended to the student community and this objective has been amply fulfilled. It is reasonably priced and is affordable.

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Theory of probability by P. Mukhopadhyay, New Central Book Agency, 8/1, Chintamoni Das Lane, Calcutta 700 009, 1991, pp. 335, Rs 80.

College textbooks in this country form a genre of their own, so to say, with their unmistakable pedantic style, their rigid conformity to a syllabus and total orientation towards grooming its reader to produce expected responses to all-too-predictable examination questions. Any deviation from these norms is duly punished by the market forces. It is therefore quite pleasing to find a book that, while remaining within the confines of the tradition, still does a pretty good job of conveying the essence of the subject. The book under review is one such. It is designed for a course in probability for honours and postgraduate courses in statistics and mathematics.

The opening chapter of the book is a very brief essay on the nature of probability. This is followed by an extensive account of combinatorial probability (coin tossing, rolling of dice and all that), to be followed in turn by the rigorous formal (or 'axiomatic') treatment pioneered by Kolmogorov. Subsequent chapters treat the usual 'basic' topics in probability theory—expectations, moments, generating functions, functions of random variables, stochastic convergence concepts and two basic limit theorems—the weak law of large numbers and the central limit theorem. A considerable part of the book is devoted to introducing several probability distributions on the real line (both discrete and continuous) and on n-dimensional Euclidean space. A whole chapter is also devoted to measures of dispersion, central tendency, skewness, etc., and another on assorted 'generating functions'. These underscore the author's bias for statistics—the book is clearly written with statistics majors in mind.

As already mentioned, the book is very much a conventional text. All the same, it is written by a

scientist from a premier institution and that shows. The exposition is clear and the treatment of mathematics quite rigorous (One has learnt not to take these things for granted) Also included is a generous dose of worked-out examples and exercises which should go well with the students.

One point to ponder (or worry) about is why an honours or postgraduate course in probability does not go beyond distributions on n-dimensional Euclidean space and elements of stochastic convergence. But that, of course, is not the fault of the book or its author.

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Cyberspace: First steps edited by Michael Benedikt, The MIT Press, 55, Hayward Street, Cambridge, Massachusetts 021 142, 1991, pp. 436+viii, $24.95.

This book contains expanded and revised versions of presentations made at the First Conference on Cyberspace in '90 and some written specially for this volume.

This is a difficult book: there is a wide variety of subjects and widely different styles of writing by authors working in many different disciplines (architecture, anthropology, feminism, computer science, human interface design, etc.). Some are technical (Chapter 7: Cyberspace: Some proposals), some are written in the style of academic social science (a good example is Chapter 3: Old rituals for new space. Rites of passage and William Gibson's Cultural model of cyberspace) and some require considerable exposure to science fiction to follow some of the nuances (Chapter 2: Academy leader by Gibson–the visionary in this book). For this reason, the book is likely to be difficult for almost all categories of readers that may be interested. To give a flavour of the book, we will present some of the chapter summaries.

Chapter 1 (Introduction) lays the groundwork of the book by the editor who is a professor of architecture. He uses the insights of Popper (concepts of the three worlds: world of nature, world of beliefs, and world of autonomous constructs–similar to Plato's ideal forms–like scientific theories, etc.) and claims Popper's World 3 as cyberspace. Chapter 2 (Academy leader) is a short fragment from a science fiction story by Gibson.

Chapter 3 (Old rituals for new space: Rites of passage of William Gibson's Cultural model of cyberspace) explores cyberspace from an anthropological perspective for three reasons: making sense of rapidly emerging post-industrial culture, studying the impact of advanced information technology not only on the economic structure of human societies but also how it undermines the sensorial and organic architecture of the human body. It draws parallels between the rites of passage found in many tribal cultures and seeks to understand whether these insights can be valuable for those who seek to move in and out of cyberspace.

Chapter 5 (Erotic ontology of cyberspace) moves back and forth between widely different topics but with emphasis on what it means for a cognitive system to simulate the body. It is not clear that such a system is possible but this is neatly sidestepped as science fiction is the inspiration! In the analyses, complete information is assumed to be possible for supermonads, sysops...without any concern for either undecidable or computationally intractable problems. There is some good discussion on the dangers of future advanced systems that blur the distinction between human and cyber personas but some of it is already well known.

Chapter 6 (Will the real body please stand up? Boundary stories about virtual cultures) explores the world of artificial universes that are possible due to virtual reality and cyberspace. Networking is an example of an earlier technology that enabled this to some extent by the ability to create a network persona that is quite different from the real person (a man assuming the persona of a paraplegic but life-affirming woman and 'tricking' many women to discuss with 'her' their personal problems).

Chapter 7 (Cyberspace: Some proposals) is a detailed look at the organizational principles of cyberspace. In the first part of the chapter, the author proposes some 'axiomatic' principles that would not violate 'cyberlaws'. For example, consider the 'principle of transit': "the travel between two points in cyberspace should occur phenomenally through all intervening points, no matter how fast (save with infinite speed), and should incur costs to the traveller proportional to some measure of the distance."

This is argued by the author as a necessary principle even in the presence of near-instantaneous access through gigabit networks and the like as the access can never be totally instantaneous. Similarly, the 'principle of indifference' (a cyberworld is held to be realistic only if life goes on whether one is there or not), the 'principle of exclusion' (similar to Pauli's principle: two things cannot be in the same place at the same time), etc. In the second part of the chapter, the author considers the question of how much of cyberspace should be symbol sustained, maintaining that 'post-symbolic communication' as hoped for by some of the pioneers in virtual reality as unlikely. This is an important issue as the task of designing dynamic, three-dimensional, cyberspace structures (mainly databases) requires an awareness of cyberspace as an evolving rather than a revolutionary medium. This chapter is written in a very clear and didactic way but the length of the article may be deterrent for a casual reader.

Chapter 10 (The lessons of Lucasfilm's Habitat) deals with the attempt to create a very large scale, commercial, many user, graphical virtual environment. This cyberspace had Avatars (inhabitants), tokens (money), teleports (long-distance transport), sysops, books, keys, and many other daily objects. The authors warn against fascination with display technology and offer good advice when building large systems. They also give good examples of unusual behaviour that could not be predicted in advance. However, they do not motivate why the Habitat system is needed.

Chapter 14 (Corporate virtual workspace) is a very interesting chapter on how work might be restructured in the future using an example of a software engineer working at home and interacting with another colleague by means of private and corporate virtual workspaces. How these workspaces help in creating or simulating the work environment is brought out very well.

The book does not have an index and the proof-reading has not been done very consistently. For example, on p. 100, line 28, 'he' is used instead of 'she' (similarly, typographical errors: p. 346, Fig. 12.5, scripset instead of scriptset.)

Even though the book is likely to be difficult reading due to the wide variety of topics and writing styles, it still serves as a very useful introduction for anyone who is attempting to get a feel of the kinds of technologies that visionaries are thinking of for the future. Some of them look pie-in-the-sky but due to the rapid decrease in hardware costs, software may be available for such systems in as few as 5–10 years. One wishes such technologies are available in India too as early as possible as contentious issues like Ayodhya can be neatly sidestepped through virtual reality (where each person can have his/her own vision of the land)!

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The art of the metaobject protocol by Gregor Kiczales, Jim des Rivieres, and Daniel G. Bobrow, The MIT Press, 55, Hayward Street, Cambridge, Massachusetts 021 142, USA, 1991, pp. viii + 338, $45.

There has been considerable interest in object-oriented programming and techniques since the availability of Simula67. Currently, there are a host of contenders like Smalltalk80, C++, Objective C (used by NeXT), Common Lisp Object System (CLOS), SELF, and more recently, Dylan from Apple. Even amongst the Lisp community, there have been versions like Flavors and Loops in addition to CLOS leading

to confusion. One way to reduce this confusion is to have a core of language constructs that can be extended efficiently to mimic other desired alternative behaviours. This is an advanced book on how to make CLOS or a similar language extensible. The authors are some of the well-known designers of CLOS.

The book is meant for an expert CLOS programmer rather than for a novice. Even others who are familiar with other object-oriented (OO) languages like C++ might find the going difficult as the 'feel' of the language is sufficiently different–this in spite of an appendix which gives a short tutorial of CLOS. This is so as most of the book is about how to implement 'metaobject protocols' and code has to be read quite closely to understand the ideas. For example, the definition of a defclass is given through a defmacro (p. 19) but the exact syntax of defmacro (explaining the meaning of tokens like "`", "," and "@") is not available in the tutorial or in a book on CLOS that the authors recommend[1] or in other references like Milner and Moon[2,3]. This makes the book accessible only to those who have Steele's book or otherwise proficient in CLOS! This is unfortunate as the interesting ideas that are behind the metaobject protocols (reflection and extensibility) deserve to be known more widely.

The first part of the book deals with the design and implementation of metaobject protocols. The first chapter discusses the implementation of a simplified version of CLOS ('Closette') and discusses the 'backstage' objects or metaobjects that are needed. Using the macro facility in the CLOS language, language constructs like defclass, defgeneric and defmethods are implemented using the underlying class metaobjects, generic function metaobjects and method metaobjects. Given that the structure of these metaobjects is available, they can now be made available for introspection (reflection) and analysis, which is taken up in the next chapter by introducing special constructs like find-class and class-of. These are not enough as extensibility is not yet possible. These are made possible by the introduction of intercessory protocols that enable modification of the metaobjects (Chapter 3). A full example of how to modify the class-precedence-list under certain constraints (protocol) so as to mimic the behaviour of Loops or Flavours is presented. The protocol adopted in this case is that this list be a fixed property of the class, that it include all of the class's superclasses and that the latter include the classes standard-object and t (the top of the object heterarchy). These restrictions are not onerous but enable extensibility. The power of such protocols is further demonstrated by a few other examples like providing attributes for slots and close control on the allocation of storage to slots that are only sparsely needed.

Chapter 4 continues discussion on protocol design; the concepts of functional and procedural protocols are introduced. In the former (the previous case of class-precedence-list is an example), due to the constraints in the protocol for functional behaviour, efficiency is possible with memoizing. On the other hand, procedural protocols do not have many constraints and affect the system behaviour directly. They cannot be memoized as causing behaviour, not producing an answer, is the primary purpose. Some issues concerning layering of protocols and how to efficiently handle procedural protocols that are on the critical execution path are discussed in later sections.

In the second part of the book, the detailed specification of a metaobject protocol for CLOS is specified. The two chapters are more of the nature of a reference manual.

A recent textbook by Friedman, Wand and Haynes[4] also has a chapter on object-oriented languages that may be more accessible due to the simple and didactic nature of the base language (Scheme). The spirit of this chapter is similar to the one followed in the book under review as an implementation is developed and the corresponding meta-classes (meta-objects) are derived. However, meta-object protocols are not developed explicitly. For this reason, it might be useful as introductory material before this book is tackled.

The getup of the book is attractive but some errors have crept in. For example, in Appendix C, while discussing how issues of circularity, bootstrapping and metastability can be handled, reference is made to page 1.3 which should be actually be section 1.3! (Similarly, in the same appendix, p. 270: line 20: much → must).

The book is recommended to experienced programmers in object-oriented languages but knowledge of Common Lisp and CLOS is also necessary!

References

1. KEENE, S. E. *Object oriented programming in Common Lisp*, 1989, Addison-Wesley
2. MILNER, W. L. *Common Lisp: A tutorial*, 1988, Prentice-Hall
3. MOON, D. A. The Common Lisp object-oriented programming language standard, in *Object-oriented concepts, databases, and applications*, W. Kim and F. H. Lochovsky (eds), 1989, Addison-Wesley.
4. FRIEDMAN, D. P., WAND, M. AND HAYNES, C. T. *Essentials of programming languages*, 1992, MIT Press.

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Space safety and rescue 1988–1989 by Gloria W. Heath, American Astronautical Society, P.O. Box 28130, San Diego, California 92198, 1990, pp. 485, $70 (hc), $55 (sc). Orders to Univelt Inc., P.O. Box 28130, San Diego, CA 92198.

The book under review is the proceedings of the twenty first and twenty second Annual Symposia on Space Safety and Rescue held in 1988–89, and therefore contains a conglomeration of papers presented. Before a review of the articles in the book is undertaken, it is worthwhile to reflect on the theme of these Symposia. These Symposia reflect the global concern on the safety and rescue operations of crew in space missions. The distinguishing feature of this volume is that, as distinct from the first twenty Symposia, for the first time, the impact of space activities on the environment, both in space and on the Earth, has been assessed.

As is to be expected in research of this sort, most studies are qualitative, except in the rare cases where statistical data are available. Participants from the European Space Agency's (ESA) safety program, initiated in the early 1970s, describe their policy, which intends to protect human life, investments and the environment. The reformulated safety program of NASA is described in a subsequent paper.

The advent of the space station Freedom poses new questions in safety management, as extra vehicular activity is vital to the space station. Some of the new questions are addressed in the first and third parts of the volume. For instance, concepts to safeguard against the inadvertent separation of crew or equipment from the space station are discussed in one of the papers.

During the past thirty years, several thousand satellites have been launched into space for various purposes. At the end of their mission, these satellites are either left undisturbed or exploded in space. The question of the effect of space debris on the environment, both in space and on the Earth, which constitutes the second and fourth parts of the volume, makes interesting reading. It is commendable that studies have been initiated on such an issue at this stage, before it goes out of hand, unlike its counterpart, the problem of terrestrial pollution. The lack of data again confines one to qualitative statements. Most have condemned the littering of the orbit with man-made debris. The qualitative estimate is that half the satellite population in orbit comprises orbital debris. Most disturbing is the observation that the debris generated by the collisions can initiate a self-sustained chain reaction which could lead to the formation of an artificial debris belt, making spaceflight in certain altitudes impossible for many centuries.

In conclusion, although the book is meant for scientists seriously engaged in the study of space safety, it makes interesting reading even for the layman.

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