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BOOK REVIEWS

Science and technology in Indian culture-A historical perspective edited by A. Rahman. National Institute of Science, Technology and Development Studies, Hillside Road, New Delhi 110 012, pp. iv + 251, 1984, Price not stated.

Science and technology in Indian culture is the outcome of the studies carried out by NISTADS and forms the foundation day lecture series of the Institute. These studies were conducted at Calcutta for ancient period, at Lucknow for medieval period, and at Delhi for colonial and post-independence era. These papers deal with conceptual framework, raise a few basic questions as well as describe specific developments in a period of Indian history. Rahman asserts that Indian civilization and culture had scientific ethics and technical bias. There is a dearth of studies pertaining to the nature of science and technology and their various linkages with the society. NISTADS has undertaken this task with a view to link the past with the present; closer links are to be established between science and culture and to see the contemporary developments in the historical perspectives. In this book, an effort is made to look beyond the Euro-centric view of science and technology and to have a secondary look at our own scientific and technological traditions. The growth of science has to be seen from social, cultural, ethical and philosophical angles.

The historical studies of science and technology in China have brought to focus the contribution of non-European science and its contribution to international tradition. Rahman wonders if the same holds good for India also. In India there was some development in science but technological development was not substantial.

The ancient period is covered in three papers by D.P. Chattopadhyay, Navjyoti Singh and Anuradha Khanna. D.P. Chattopadhyay on the basis of V.G. Child's (1950) *The urban revolution* observes that there was a dark period of nearly one thousand years between the urbanization that is Indus civilization or Harappa culture and the second urbanization which started some time in the middle of 6th Century B.C. The intervening period was dark because the art of writing was lost and so also the art of making burnt bricks. This was also the period of technological regression. The author does not find much scientific and technological material in Vedas. Chattopadhyay examines the position of geometry and burnt bricks in ancient Indian literature. Geometry finds mention in Sulva-Sutras or Sullea-Sutras. The word brick occurs in Yajurveda and Sathpatha Brahmana as 'Istaka', but the author doubts if the people during this period know the art of making burnt bricks. For the richness of scientific and technical knowledge of the ancient Indian literature, it is hoped that linguists and indologists will do some work in this important area.

Navjyoti Singh in an illuminating paper points out that Subhas Sastras of Apasthana, Badarayana and Katyayana reveal a high level of knowledge of linguistic, logic and algebric mathematics. Greek mathematics developed pure deductive logic whereas Indian mathemat-

ics flourished with algorithmic logic and it was algebric. Linguistic developement was the earliest scientific development in India. Paninean grammar provides the possibility of semantic interpretation. He also compares it with Chomskian attitude and also with Euclid.

Anuradha Khanna observes that body-matter and environmental matter were conceived as constituent from five elements that is earth, water, fire, air and akasa (sky). This fundamental identity paved the way to a highly developed system of medicine which is based on Rasa Theory that is correlation of elements, qualities and senses. It is an indication of the chemical knowledge of the ancients. This paves the way towards a better understanding of both the microcosm and macrocosm.

The medieval period is covered in three papers by A. Rahman, Irfan Habib and Nazir Hasan Abdi. Rahman focusses on the Islamic influence in the fields such as agriculture, horticulture, architecture and metallurgy. The nobility concerned itself with astronomy, mathematics, medicine and metaphysical speculations. The tradition of agriculture and technology was carried out by farmers and artisans. The need of weapons for the army induced the development of such areas as mining, metallurgy, design of weapons and allied technological developments.

Habib and Abdi discuss the impact of Asian culture on Indian science and vice versa. There was an exchange of knowledge in mathematics, astronomy and medicine between India and other Central/western Asian countries. Al-Beruni's Kitabal-Hind is an example of Indo-Arab interaction in science and technology. The Indian astronomy was influenced by Assyria and Babylonia. India had contributed in mathematics, medicine and silk technology to these countries.

The colonial period is covered by Satpal Sangwan and Deepak Kumar. Science made a definite contribution in the establishment and consolidation of the British empire in India. The fate of science depended on the political conditions and the level of individual tastes and efforts. The colonial period was marked by surveys and explorations. In the field of agriculture, the British achieved some success in the growing of tea in Assam and cotton in Bombay. Sangwan observes that the lack of real scientific approach and balanced policy was the main cause of failure in agriculture. The British also undertook civil engineering works, steam navigation, railways and electric telegraph. The East India Company provided education in medical and survey schools but agriculture education and Indian classical sciences were neglected. Commenting on the scientific policy of the East India Company, Sangwan observes that science failed to emerge as an organised institution.

Deepak Kumar observes that the emphasis in science and agriculture was on cash crops. Demands for sinking more capital in agriculture were made throughout the 19th century, but the government restricted proposal for expenditure on agricultural improvement to the minimum amount required only to meet immediate needs. At the same time some well-intentioned scientists pressed for research and innovation in agriculture, but the Government did not pay much attention towards them. There was some initiative from private entrepreneurs in agriculture

Post-independence era is covered by M.A. Quereshi and A. Rahman. Qureshi alleges that institution building is strongly related to bureaucratic rules and procedures, but the same

bureaucracy has been quite successful in creating a defence against the public criticism of science. The author stresses the need for the evaluation of scientific programmes, functioning of the research and development institutions and accountability of the implementation and of the programmes. There is a need for greater interaction between the research scientists and university academicians for better results. A lively public discussion on the performance on science and technology in the country is necessary for providing linkages of R&D to socio-economic needs and increasing the application of S and T for self-reliance.

Rahman sees an urgent need for a critical assessment of the 1958 Scientific Policy resolution to know what has been achieved and what is required to be achieved and whether any modifications are to be incorporated in the light of the experience. Secondly, science has to be spread among people in order to promote scientific outlook, to make people aware of their problems and the possible ways of solving them. Rahman holds that the future of India would depend upon how much she is able to learn from her historical heritage, discarding the colonial outlook, undertakes analysis of the contemporary scene and how much effort she is able to put in giving a scientific and technological base to the society and to do away with exploitation, inequality and injustice.

Rahman enquires whether the contemporary science should lean heavily towards the west and accept continuously and uncritically the value system and direction or should India not learn from past culture and civilization and present a new perspective and vision of future. This is food for thought and future direction. The editor hopes that this book will evoke considerable interest and lead to detailed discussion and research on the problems of historical development of science and technology in India.

In sum, it is hoped that the linguists, indologists and members of scientific and technical community will take some interest in the issues raised in the book. The researches in science and technology have to move in the direction of fulfilling the needs and aspirations of the society and to ameliorate the conditions of the masses. It calls for a greater interaction between science and society. The utility of historical studies lies in the generation of ideas, which in future may provide a source of knowledge and practical application. Prof. A. Rahman and other contributors deserve gratitude of the reader. The book is sure to receive a large audience.

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Observation, experiment, and hypothesis in modern physical science edited by Peter Achinstein and Owen Hannaway. The MIT Press, 28, Carlton Street, Cambridge, Massachusetts 02142, 1985, pp. 379, $ 40.25.

The book is a collection of papers, presented in the academic year 1982-83, devoted to the special theme appearing as the title of the book, at the Johns Hopkins Center for the History and Philosophy of Science founded in 1969.

Although philosophers hold and propound widely different views on any subject, no convergence being ever achieved, their efforts are necessary in striving for wider and deeper

comprehension of all intellectual activity. This is all the more true for such profound subjects as the nature of space, time, relativity, complementarity and uncertainty relations in quantum theory, the nature and role of hypothesis, observation, validation. Equally important is the study of the historical emergence and evolution of concepts and development of new experimental techniques. Such is the range of the cogitations of the several professional philosophers and historians of science, the results of which are presented as papers in this collection. None of the authors is an active participant in the activity of developing the science they are writing about. So you do not find here physicist-philosophers of the kind of Bohr, Heisenberg, Schrödinger, Born or a physicist-historian like Pais. Therefore, it is all the more interesting for working scientists to see how their work and its history appears to thinkers from the outside.

The philosophical essays are concerned mainly with the general theme of the hypothetico-deductive method in science, and with the question of the vocabulary -'theoretical' and 'observational'- used in scientific activity. What is the role of hypothesis? What is the role of observation? And of the nature and necessity of the theoretical framework in which an observation is planned, carried out and assessed with the purpose of testing a theoretical scheme? A variety of points of view is presented and critically discussed in the philosophical contributions to the volume. The shifting sands of mental activity is difficult to grapple with. Yet the philosophers have always had a go at it. Questions such as that of an 'absolute' distinction between the observable and non-observable have a tantalizing hold on the philosophic mind. Readers will find in the volume a number of different points of view that can be quite stimulating.

Less demanding, and possibly more interesting for a wider class of scientific readership, are the three historical contributions. A great deal of painstaking scholarly research has gone into these papers. Rigden goes into the history of the magnetic-resonance method. Stuewer tells the little known story of a controversy on the observations of artificial nuclear disintegration between the Rutherford-Chadwick-led Cambridge group and the group led by Pattersson in Meyer's institute at Vienna. In spite of the bitterness and embarassing situation that had gradually developed it is praiseworthy that no bad odour was allowed to spread by the involved participants. The story of the development of today's 'big science' multinational character of experimental high energy physics is related by Galison in his paper on bubble chambers and the experimental work place. It all started with Glaser seeking to develop a method for studying cosmic rays in an independent small way removed from the 'factory atmosphere'. He developed the bubble chamber concept, which, however, proved just right for use with the big accelerators involving huge outlays in money and requiring large teams of physicists and engineers.

The book is beautifully printed. It would be a good addition to the institutions of higher learning and research.

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Critical phenomena (Proceedings of 1983 Brasov School Conference) edited by V. Ceausescu, G. Costache and V. Georgescu. Birkhauser Verlag, P.O. Box 133, CH-4010, Basel, Switzerland, 1985, pp. 438, S. Fr. 84.

The theory of critical phenomena, though more than a hundred years old, continues to be a challenging problem. In spite of sustained efforts from many directions, there is as yet no rigorous theory of phase transitions in three dimensions based on fundamental principles. This is not to belittle the progress made. The van der Waals equation of state, the Landau scheme of phase transitions, the Ising, Heisenberg and other mathematical models, concepts of symmetry breaking and above all the renormalization group theory have given valuable insights, explaining many facts of the observed phenomena. In the last decade or so mathematical developments in both statistical mechanics (SM) and quantum field theory (QFT) have opened out newer ways of tackling these problems. Since the input developments have come from different disciplines and the output information is used by workers with diverse backgrounds, a topical workshop is an ideal form to review the progress. The present book is an edited version of one such workshop conference held in Rumania in the summer of 1983.

The contents of the book fall into three distinct themes, namely the critical phenomena in SM and QFT, the critical phenomena in nuclear and particle physics and thirdly the exactly soluble mathematical models. A few related topics are also represented in the book.

The early rigorous attempts to study critical phenomena began about 50 years ago using the standard techniques of statistic mechanics, introducing new ideas like virial expansions, linked diagrams and cluster integrals. The zeros of the grand partition function gave additional indications. These techniques, refined and extended by applications to quantum field theory, have reappeared in different forms and yielded, for example, the renormalization group theory of phase transitions. The first part of the book covers these topics and indeed the titles of the articles are the best summaries: 'Kosterlitz Thouless transitions and Mayer expansion', 'Zeros of partition function for statistical models on regular and hierarchical lattices', 'Phase structures of finite temperature gauge theories', 'Scaling limited and DLR equations in Euclidean field theory', and 'Critical behaviour and renormalization of quantum fields'.

While the conventional critical phenomena belong to the realm of condensed matter physics, similar transitions from single particle excitation to collective excitation behaviour were observed about a decade ago in the inertial parameters of high spin states of nucleii. These transitions are discussed in the second part of the book, using self-consistent expansions, group symmetrics and coherent state separations, thus bringing about an interplay of the concepts from particle, nuclear, solid state and statistical physics. The third part of the book deals with the progress in solving exactly the mathematical models of phase transitions. Reading the text, one may get the impression that Onsager's famous 1944 solution of the two-dimensional Ising model in zero magnetic field is taken for granted, although it was a *tour de force* at that time. Several two-dimensional models have been exactly solved, as discussed in the book. It is however an interesting quirk of fate that so far no three-dimensional model has been solved exactly. This remains a challenge in theoretical physics.

The production of the book is quite pleasing. The 1983 summer school proceedings has come out in 1985. Since the articles are based on talks given in the summer school, some amount of informality is pleasantly obvious. For example, C.J. Thompson, in his article, teases the audience with a paradox attributed to the French mathematician L.F. Bertrand. Choose a circle of radius R. The length of the side of an inscribed equilateral triangle is $R\sqrt{3}$. If a chord is chosen at random, what is the probability that its length L will exceed $R\sqrt{3}$? On the one hand, if one fixes an end point of the chord L (which is allowed by symmetry), then L will exceed $R\sqrt{3}$ if the other end point of the chord lies in the opposite one third of the circumference and so $P(L \geq R\sqrt{3}) = 1/3$. On the other hand it is easy to see geometrically that L will exceed $R\sqrt{3}$ if the centre of the chord lies in the interior of the concentrate circle of radius $R/2$. Taking the ratio of the areas of the two circles $P(L \geq R\sqrt{3}) = 1/4$. How does the probability P have two values or does it have infinitely many values between $1/3$ and $1/4$?

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Complex analysis in one variable by Raghavan Narasimhan. Birkhauser Verlag, P.O. Box 133, CH-4010, Basel, Switzerland, 1985, pp. 266, S. Fr. 84.

Many books are available on functions of a single complex variable and whenever a new one appears on this topic, not only the presentation of the material counts but there must be something distinct from the other books to justify one more on the topic. In this review we bring out the distinctive nature of this title from the other books available on this topic.

This book is written not just to bring out facts on functions of one variable but the entire theory is developed with the applications to other branches of mathematics, specially to partial differential equations, number theory and extensions to several complex variables in mind. Also the order in which the topics are covered is one of the plus points of the book, for it gives a very fast insight into the subject. Moreover some of the topics covered in this book are not usually found in other standard text-books.

Apart from the routine material, like definition of complex differentiation and properties of holomorphic functions, the first chapter contains Looman-Menchoff theorem, which is a regularity result for the Cauchy-Riemann equtions $\frac{\partial U}{\partial \bar{z}} = 0$. Also this chapter contains a brief introduction to the concept of first cohomology and the existence of primitives when the first cohomology vanishes is proved. This cohomology concept is developed further in chapters six and nine where the cohomology version of the Cauchy's theorem and existence of meromorphic functions on compact Riemann surfaces are proved.

The second chapter deals more with topological results like covering spaces, lifting of mappings and introduces the concept of manifolds, sheafs of germs of holomorphic functions. Also homotopy version of the Cauchy's theorem and the Monodromy theorem are

proved. These ideas are used in chapter three to define the winding number and develop the residue calculus.

The fifth chapter deals with the existence of solutions of inhomogeneous Cauchy-Riemann equation $\frac{\partial U}{\partial \bar{z}} = f$ and as a consequence, the Runge's theorem is proved which deals with approximation of holomorphic functions by rational functions. This method of solving $\frac{\partial U}{\partial \bar{z}} = f$ can be generalised to study the properties of holomorphic functions in several variables. A glimpse of this can be seen in the proof of Hartog's theorem presented in chapter eight. Such a result is not true in one variable and much more can be said in the case of one variable: *i.e.,* given any domain $\Omega \subset \mathbf{C}$, there exists a holomorphic function f in Ω which cannot be analytically continued to a bigger domain containing Ω. This is a consequence of Weierstrass theorem proved in chapter six.

The remaining chapters deal with the study of the Laplace Operator $\frac{1}{4}\Delta = \frac{\partial^2}{\partial z\, \partial \bar{z}}$ and its applications. For example, the author presents a proof of big Picard's theorem in chapter four without using the modular function. This way of proving has far reaching generalizations in several complex variables as well as in differential geometry. In chapter ten a simplified proof of Corona's theorem is given and in chapter eleven the Dirichlet problem for Laplacian is solved using subharmonic functions.

The book is well suited for a graduate course on complex analysis of one variable. However, one main drawback is that there are no examples and exercises to illustrate the theory and hence there is need to supplement if this book is to be used as a text.

There are some typographical errors which however the reader can correct on his own.

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The foundations of program verification by Jacques Locckx and Jurt Sieber. Wiley Teubner, 1984, pp. 226, DM55.

This is a very well-written, self-contained introductory text on program verification. It concentrates on those verification methods that have now become classic such as the inductive assertions method of Floyd, the axiomatic method of Hoare and Scott's fixpoint induction. The authors do not try to substitute readability for mathematical precision. However, many examples are included for a better understanding of the techniques presented. Further, by using the same examples to illustrate different techniques, the authors attempt to convey an idea of how the different methods are related.

Three representative programming languages have been considered; a flowchart programming language, a language of while-programs and a language of recursive programs. The constructs examined are essentially the assignment, the if-then-else statement, the while-statement, the jump and the procedure with value parameters.

The book begins with a brief introduction to the mathematical background required, which consists mainly of induction and predicate logic (the reader is assumed to have an elementary knowledge of programming languages, formal languages and the theory of computation). Next operational semantics and denotational semantics are introduced for the description of the semantics of programming languages.

The third and main portion of the book concentrates on verification methods. The notion of correctness of a program is given a precise definition. Floyd's inductive assertions method is described for use in proofs of partial correctness, and the well-founded sets method is presented for proofs of termination. In the following chapter the verification method of Hoare for proving the correctness of while-programs is presented after introducing the Hoare Calculus. The notion of expressiveness is also discussed, and a generalization of the Hoare Calculus for total correctness is sketched. The methods next described are those based on denotational semantics. The use of some properties of denotational semantics *e.g.* the Fixpoint Induction Principle and Parks Theorem in constructing proofs are illustrated. The structural induction method is later introduced. Finally Milner's Logic for Computable Functions (LCF) is introduced and discussed.

The book contains exercises at the end of each chapter. It is suited for a graduate level course on the topic as a considerable level of mathematical maturity is essential for an understanding of the subject.

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Pulse transformers: Design and fabrication by M.A. Nadkarni and S.R. Bhat. Tata McGraw-Hill Publishing Co. Ltd., 12/4, Asaf Ali Road, New Delhi 110 002, 1985, pp. 156, Rs. 27.

This book is a compilation of international material prepared originally in cyclostyled/offset printed form by the Indian and Swiss engineers and the staff of CEDT, Indian Institute of Science.

In the introduction the current trends in pulse transformers are brought out very well and the difference between pulse transformers and optocouplers have been brought out very clearly.

The analysis of the actual or real transformer as against an ideal one is done in a manner that any one designing an ideal transformer can differentiate between a real and an ideal one. Understanding the effects of magnetising inductance, leakage inductance, parasitic capacitance and low resistance, pulse response characteristics for both linear and non-linear source and load effects have been dealt in detail, so that any one who uses this book can apply the analysis to the existing conditions without much difficulty.

The book goes on to describe the design procedure and the examples given are exhaustive and detailed so that any kind of pulse transformer can be designed with ease.

Chapter 4 of the book is the best, complete with drawings and tables of different types of cores and windings, etc. The student will find the information most useful.

Testing and evaluation are very important and necessary procedures before using any electronic or electrical component. Therefore, the detailed test procedures given in this book are very appropriate.

The applications described are good. Though the triggering of triacs is similar and not quite the same as that of SCRs, one para on triac triggering could have been included. On the whole the book is well-written and arranged and it would be good for every technical library.

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From spacelab to space station edited by H. Stoewer and Peter M. Bainum. Advances in the Astronautical Sciences, Vol. 56, American Astronautical Society, 1985, pp. 270, $ 40. Orders to Univelt, Inc., P.O. Box 28130, San Diego, CA 92128.

The volume presents the proceedings of the Fifth AAS/DGLR Symposium organised by the American Astronautical Society, the Deutsche Gesellschaft fur Lüft-und-Raumfahrt, and the American Institute for Aeronautics and Astronautics, held during October 3-5, 1984 in Hamburg, Germany. It includes 15 papers related to spacelab flight results, space station system architecture and technology and space station plans. The volume begins with some remarks by Dr. Wolfgang Finke on German space policy for 1985-1995. It covers a brief history, the present programmes, and financial and political implications of the future programme. The next paper covering the Eugen Sänger Memorial Lecture by H.E.W. Hoffman describes how Europe has developed the Spacelab during the ten years. After these two general papers on the past and the future decades, three papers summarize a few flight results from Spacelab-1. The first of these discusses the in-flight performance of Spacelab-1 including a few examples of performance of its subsystems. Selected results of experiments from all disciplines represented in the first flight of Spacelab are reported in the next paper. The Shuttle Pallet Satellite (SPAS-1) flight experience is summarized through a set of view graphs in the third paper.

The section on space station system architecture and technology begins with a paper discussing technology options for development of a space station. System-and operations-related technology as well as subsystem technology options are considered. Communications, power systems, life support, and thermal control technologies for the long-life reliable operations are discussed in the next three papers. Various considerations and alternatives are presented. The last section presents an outline of the NASA's and ESA's space station program plans. The evolution of manned space flight is briefly reviewed from an operational view point. A European view point of the space station user requirements is also included. Some possible uses of the space station by the Office of Space Science and Applications are summarized in the last paper. The volume concludes with a couple of statements from participants of a policy maker's forum discussion and a summary of space shuttle payloads and experiments for 100 flights.

The volume is quite informative and interesting covering a rather wide range. Designers and planners of space systems should find it good for gaining a general appreciation of the systems under discussion. However, as expected, from papers of this kind one does not get much indepth information on any particular aspect. Also, a more critical evaluation of the alternatives considered would have added to the value of the document.

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Tools for teaching (UMAP Modules 1977-79). Birkhauser Verlag, P.O. Box 133, CH-4010, Basel, Switzerland, 1981, S.Fr. 88.

The book represents the first annual collection of instructional modules from the Undergraduate Mathematics and its Applications Project (UMAP), which have been developed for the benefit of undergraduate students and instructors. The modules are self-contained and are designed to help the students to learn current professional applications of mathematics and statistics to several inter-disciplinary fields. The value of the modules is enhanced by involving a number of people from industry in their preparation.

The topics covered include differential equations, exponential functions, probability, and several applications of calculus ranging from medicine, biology and chemistry to economics and geography.

The inter-modular description sheets are quite comprehensive, and provide guidelines for using the modules, including a specification of entry and output skills.

The modules contain lively discussions of the topics, which should serve to motivate the students to want to learn. They provide a variety of ways in which to look at the basic concepts and their applications. Some of the modules describe easily performable experiments to reinforce the concepts and to enable the students to learn by doing. The hints and suggestions for exercises will be very useful and the examples are very interesting and pertinent. After going through these modules, one can really appreciate the several different aspects of basic mathematical concepts and their applications.

A summary at the end of each chapter would have helped the students by serving as concise reference material. For example, the entire summary chapter on integration (Getting it all together - a strategy for solving integrals in calculus) is an invaluable source of reference material for the novice and expert alike.

In some cases, the examples deal with so much detail of the system being analysed (*e.g.* modelling of the nervous system) that the mathematical methods assume secondary importance. While the book will be interesting both to the student and the instructor, it will be more useful to the latter.

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