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Book Reviews

Electrodynamic theory of superconductors by Shun-Ang Zhou (IEEE Electromagnetic Wave Series 34), Peter Peregrinus Ltd, The Institution of Electrical Engineers, P.O. Box 96, Stevenage, Herts SG1 2SD, UK, 1991, pp. 320, £42.

This introductory text containing 320 pages in three chapters is addressed to applied physicists, electrical and mechanical engineers and post-graduate students and provides a phenomenological understanding of electromagnetics, electrodynamics, mechanics and thermodynamics of type-II superconductors in a user-friendly manner.

There is marked emphasis on certain aspects of superconductivity which are often excluded from most books on the subject. These aspects are electromagneto-elastic deformations and acoustic anomalies, thermoelastic coupling, co-existence of superconductivity and magnetic order, and non-equilibrium superconductivity. These are relevant to the conditions of a superconductor subjected to thermal, mechanical and magnetic loadings and, therefore, are of considerable practical importance. Chapter III of about 80 pages is completely devoted to these aspects In fact, it is this choice of topics that gives this book a distinctive character.

The rest of the book covers rather standard stuff. Chapter I (of over 100 pages) covers the basic principles of electrodynamics of deformable media. It makes this book self-contained. It could have, however, been shortened quite a bit. Chapter II is devoted to more or less standard (London) electrodynamics of superconductors and the phenomenological Ginzburg–Landau equations. The discussion of critical currents, flux pinning, ac losses and of the dynamics of Josephson junctions is good. Except for a brief discussion of the BCS theory, much of the treatment is macroscopic in keeping with the spirit of the book.

There are some minor typos. Perhaps the most amusing example is on p. 313 where 'van Vleck' has become 'van Vlack'.

The book is particularly recommended for engineers and outsiders who wish to be intelligent users of superconductors.

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Elements of ordinary differential equations and special functions by A. Chakrabarti, Wiley Eastern Limited, 4855/24, Ansari Road, Daryaganj, New Delhi 110 002, 1990, pp. 148, Rs 50.

This book consists of nine chapters and an appendix. Chapter 1 introduces the basic definitions concerning ordinary differential equations (ODEs) and linear ODEs in the main. Chapter 2 describes some elementary methods of solution of linear ODEs. Chapter 3 is concerned with the power series solution near an ordinary point of linear ODEs with analytic coefficient functions and Hermite differential equation is considered as the main example. Chapter 4 describes the Frobenius series method for solution near a regular singular point of linear homogeneous ODEs of the second order. Chapters 5, 6 and 7, respectively, give some useful properties of the special functions associated with the names of Legendre, Laguerre and Bessel. The last two chapters on existence and uniquess theory for solution of ODEs and eigenvalue problems are very brief and sketchy. The appendix lists some properties of the gamma function, the beta function, hypergeometric functions, the error function and the Chebyshev polynomials The book may be suitable for an undergraduate course in engineering.

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Finite element methods in engineering science by C.T.F. Ross, Prentice-Hall, 66, Wood Lane End, Hemel Hempstead, Hertfordshire, HP2 4RG, England, 1990, pp. 520, $ 37.95.

The book is intended to introduce to a practical engineer or an undergraduate the concepts of FEM as applied to general problems in engineering science. The discussion throughout had been rather elementary but in consequence the lack of precision or indepth discussion leaves a serious reader perplexed. Even as the intent is to address the general problems of engineering science more than 90% of the treatment centres around problems of structural engineering. In fact, only Chapter 11 and a few pages in Chapters 12 and 13 discuss the problems in other fields. A heavy emphasis on an elementary treatment has obscured an insight into basic concepts This is evidenced by a discussion of beams and frames for more than half the book (up to Chapter 6) without the reader (student?) ever getting an idea that a beam or frame element is the most basic of the finite elements! Lackadaisical treatment of the subject matter is abundant—natural co-ordinates of a triangle discussed on pages 221 and 292 will easily confuse a novice. Similarly, there is no reason why a grillage or a grid framework is to be discussed—not as part of beams and frames but after discussing the dynamic analysis by FEM. Even here the stiffness matrix is written directly without any reference to FEM analysis. Again, why was it necessary to postpone the introduction of axisymmetric elements to Ch. 12 long after the discussion of nonlinear problems? It can be claimed as a virtue that computer programs in BASIC have been made available throughout the book. On the contrary, a compendium of several programs each for a particular problem defeats the object of analysis through FEM, the basic concept of which is to provide a single standard means of analysis for all the different problems. Furthermore, in the present-day environment in which general-purpose FEM software packages are available, the user is hardly expected to write a program for his needs On the whole, there is not much to recommend about the book being useful for an undergraduate or a practical engineer.

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Galois dream—group theory and differential equations by Michio Kuga, translated from the Japanese by Susan Addington and Motohico Mulase, Birkhauser Verlag AG, Klosterberg 23, CH 4010 Basel, Switzerland, 1993, pp. 150, SFr 52.

This book with a catchy title is an invitation to mathematics, or at least some part of the subject having algebraic, topological and function theoretic components, woven together in a nontrivial way. Evidently when first published in Japanese in 1968, students carried copies of it to show off, whether or not they could understand the contents! It consists of nineteen parts, or lectures given once a week; but they are of widely varying lengths, some as short as a couple of pages, and others much more substantial.

There are two rather distinct ways in which, to a user of mathematics like a physicist, the themes of group theory and differential equations come together. One is the study and exploitation of symmetry properties of a given differential equation, in order to simplify the problem of finding all, or large families of, its solutions These symmetries naturally form a group, and in the continuous case pioneered by

Sophus Lie, very powerful tools in this direction have been developed over the decades. The present book is concerned with a different aspect, basically the topological understanding of the most appropriate space or manifold on which we should represent the solutions of a given differential equation. This is quite similar in spirit to constructing or 'inventing' a suitable Riemann surface to handle a multivalued analytic function.

The initial 'chapters' or weekly instalments are relatively light and easy to digest. The author covers, in an attractive style, such ideas as: basic set theoretic concepts and operations; partitions of sets based on equivalence relations; free groups; connectivity properties of manifolds or spaces, homotopic equivalence of curves and the fundamental group; and the case of simple connectivity. Many easily visualizable examples, with an occasional humourous touch, are given to clarify the points being made.

The author next moves on to the concept of one space being a covering of another The notion of a covering map, covering transformations and the associated group, and the behaviour with respect to the fundamental groups of the two spaces involved, are all developed. These are attractive and instinctively appealing ideas which have an easy naturalness to their development. The construction of the universal covering space of a given connected space, and the Galois property for a covering relationship, are also tackled.

In the final portion, the attention turns to function theory. For definiteness the author works on suitable connected subsets of the complex plane. The basic questions analysed are: what is an analytic function, and how do we go about classifying its singularities? What are reasonable sets of operations we can perform on given sets of functions to lead to new functions? And if a (second order) differential equation with analytic functions for coefficients is given, how can we handle its 'space of solution' and what manifold is ideally suited to represent the values and singularities of a solution? These and related questions are discussed in some detail, though complete proofs of all stated theorems are not always presented.

Second-order differential equations for functions of a complex variable are very familiar to physicists and engineers alike. All the special functions of mathematical physics arise out of such equations. The traditional approaches are summarised in such classics as Jeffreys and Jeffreys, or Morse and Feshbach. Through such treatments one is familiar with the ways to handle possible multivaluedness of the resulting solutions, construction of independent solutions, the notorious 'logarithmic case' and so on. For one trained in this way, Kuga's book helps put all this in a nice perspective. Though not meant to be a thoroughgoing textbook, one is exposed to a useful collection of mathematical ideas with a lightness of touch. In this sense this is an invitation to the subject.

One note of concern must, however, be finally expressed. This book of some 150 pages is priced truly exorbitantly. The only way out seems to be for some gifted Indian mathematicians to take up writing in a similar style, to enthuse students and show them the pleasures of areas in mathematics, but at an affordable price.

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A mathematical treatment of dynamical models in biological science by K. Smitalova and S. Sujan, Prentice-Hall, 66, Wood Lane End, Hemel Hemsptead, Hertfordshire, HP2 4RG, England, 1991, pp. 200, $ 87.95.

It is probably only in the 'rarest of the rare cases' that one would object to the title of a book itself, especially for highly specialized and technical books. Unfortunately, however, the book under review falls into this category. Though the title suggests that the book is about models in biological sciences, the contents deal exclusively with mathematical ecology, and that too, exclusively with population dynamics. Personally, being at a centre for ecological sciences, and working mainly with mathematical models, I am strongly tempted to raise three cheers for this point of view. After all, it was not very long ago that one of the highest ranking scientists from the division of biological sciences at the institute had equated biology with the study of gene regulation (on something equally miniscule in scope). On this background, the mathematical ecology backlash from totally unexpected quarters, C'zechoslovakian mathematician, is all the more welcome. But, such extremist point of view serves very little constructive purpose. An honest and fair approach would have been to use the term population dynamics (or at least, mathematical ecology, as used in the very first sentence of the preface) in the title, instead of the misleading comprehensive 'biological science'.

The next serious objection has to be raised at the very first sentence of the preface itself—"Mathematical ecology as a biological science accumulates information concerning the evolution of biological communities". Certainly, mathematical ecology is much more than that; study of population changes, spatial patterns, impact of external influences, just to name a few. Secondly, the term 'evolution' is used traditionally in a very specific sense in biology, where it refers to (small or large) changes at the genetic level. In mathematics, and more specifically, in the study of dynamical systems, too the term evolution is used traditionally in a very specific sense; here, it simply means any change in the value of the variable under consideration with time. Unfortunately, the authors have from page 1 line 1, used exclusively the mathematicians' term. While they cannot be technically faulted, the use seriously interferes with the readability and clarity. Mere changes in population size should not be called 'evolution', when biological phenomena are described. This usage becomes even more confusing because the authors subsequently go on to describe changes in gene frequencies also.

Coming to the contents of the book (in a way a more traditional review would do), it first describes the growth of population of a single species. Both differential and difference equations are described, and the standard elaboration—age structure, delay, stochastic effects, etc —are described at length, in a fully mathematical style and vocabulary. This chapter is followed by one on two species models, which lead to the next one on n-species communities. The last chapter has no biology at all, and deals with chaos and related mathematical matters. The preface describes this last chapter, with a perhaps unintentional honesty (crept in most probably during translation) as more pretentious!

One would have been willing to overlook the matters raised in the first two paragraphs had the book contained other points of interest. Regrettably, it is not so. It is not clear why and for whom this book was written. It seems mostly written for mathematicians, to enlighten them about the kinds of mathematical models used in ecology. On one hand, being accustomed to abstract representation, mathematicians probably do not need any connection between the symbols they manipulate, and the reality around them On the other hand, if demonstrating the biological relevance of the models was the goal, the book comes nowhere near satisfying it. The ecological part, whenever it is described is at best grossly simplistic and naive, and at worst, misplaced and wrong. This lack of rigour, coming from mathematicians, is rather saddening. To quote a couple of typical examples (p.7). "The carrying capacity is the maximal population density which can be sustained for a long time in the given environment (How long?) or (p.2) "the population density describes the population only approximately since the population is too large to determine the exact number of its members". The accuracy of measurement (or the lack of it) surely is not the criterion of deciding between continuous and discrete models. A somewhat more distressing slip-up is on p.42, where two different equations are described, and they are said to have the same fixed points; a moment's scrutiny reveals the two equations to be identical any way!

A positive feature of the book is that it includes many post-1980 references. Quite understandably, a number of them are of European origin. A corresponding negative feature is the omission of some of the more standard works on theoretical ecology — *e.g.*, those by R. M. May. Perhaps for the same reason, the whole body of work related to host–parasite interactions, spread of diseases and the like receive scant attention. Perhaps to marginally compensate for it (though in a haphazard manner), topics such as game theory, and examples such as loss of plasmids from bacterial cells, are introduced, rather out of the blue. The index at the end of the book is just about one page, making it a more ritualistic than useful inclusion.

The description inside the cover page suggests that the book contains original presentation of very extended and deep problems, and a coverage of new results. Even if one assumes this to be true, the implications of these to biological systems are probably visible (and perhaps even self evident) only to mathematicians; lesser mortals cannot hope to grasp them. In fact, this book would be either enjoyable or useful (but unlikely to be both) to mathematical ecologists (mathematical dominant, ecology recessive) and theoretical biologists (more theoretical than biologists) Those dynamical systems theorists engaged in a game of one-upmanship with say number theorists or differential geometers would profit most from this book, to show off to these innocents that dynamical systems theory has so much to offer to ecology (and by implication to enviromental science, on to Agenda 21 and Rio Summit). They perhaps may not mind shelling out $ 87.95. For others, not really a book one would wholeheartedly recommend.

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Men and women of space edited by Douglas B. Hawthorne, Univelt, Inc., San Diego, CA 92128, 1992, pp. 904+13, $ 90.

This monumental reference book contains biographies of spacefaring persons from all over the globe. The exhaustive bibliographies of over 800 astronauts and cosmonauts who have actually flown and candidate members as well as those on ex-atmospheric suborbital flight that reach or exceed 80 km of altitude, are presented in an orderly fashion. This excellent book contains equally well-written introductory section summing up the systematic arrangement of bibliographies and five appendices. A chronological list of about 200 missions including a dozen X-15 suborbital flights is given in Appendix 5. Here, information such as prime and backup crew, place and time of launch as well as landing, mission duration for each of the mission are compiled. The first flight in the human history is made by Yuriy A. Gagarin (German S. Titov as backup) on Vostok-1 (Cedar) on April 12, 1961 at 9:06:54 am (Moscow time) from Baykonur Cosmodrome, Kazakhstan (in erstwhile USSR). Vostok-1 went around the Earth once and the flight lasted 1 hour 55 minutes. The last entry on space mission is STS-45/OV-104 Atlantis with seven crew which was launched on March 24, 1992, from Complex-39A, Kennedy Space Center, Fla, USA. The mission was in operation for 214 hours 10 minutes 26 seconds and it orbited the Earth 143 times.

The bibliographical entries on astronauts and cosmonauts are organized in alphabetical order in the first 831 pages of the book. These entries fall into the following categories: NASA astronauts and candidates; Manned orbiting laboratory pilot astronauts; X-20 DynaSoar pilot astronauts; X-15 military and civilian research pilots; Military astronauts-designees of the early 1960s; Shuttle payload specialists and passengers; International cosmonauts trained by USSR. The details under each of the bibliographies are elaborate. The first item of each entry states the nature of assignment of the corresponding astronaut/cosmonaut. For example, Rakesh Sharma (see p. 652): Indian cosmonaut–researcher (flight), Soyuz T-11/ Salyut 7/ Soyuz T-10, Soviet international program, the first Indian to make space flight. Similarly for Neil Armstrong: NASA pilot-astronaut (Group 2, 1962), the first person to walk on Moon; former X-15 civilian research pilot. The other entries are on: Date and place of birth, Nick name, Military affiliation, Marital status, Children, Education, Experience (illustrative), Space flight assignment, Sources (of collected information), and also some attributes like decoration and awards, recreational interests, physical description, place and circumstances of death (wherever applicable), writings. It is really a great pleasure to go through the above details of well-known and lesser known (owing to meager information in open literature) astronauts/cosmonauts.

The reviewer finds the book a very valuable addition to all libraries and useful to people from all walks of life. It can inspire a lot of youngsters in the years to come. It is hoped that the second edition will be equally delightful and will be able to meet the high expectations generated by this book.

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Spaceflight mechanics edited by R.E. Diehl, R.G. Schinnerer, W.E. Williamson, and D.G. Boden, Advances in Astronautical Sciences, Vol. 79, 2 parts, AAS Publications, Univelt, Inc., San Diego, CA 92128, USA, 1992, pp. 1293+18, $ 240.

The proceedings of the 1992 Spaceflight mechanics have been systematically organized in two volumes. The Conference hosted by the American Astronautical Society and AIAA was held at Colorado Springs, Co., on February 24–26, 1992. The Conference dwells on analytical and numerical aspects of astrodynamics and celestial mechanics, with emphasis on application to current and future space missions. In all, 85 papers were presented in twelve sessions. These sessions were: Orbit determination; Tethered satellite systems; Celestial mechanics; Optimization; Flexible body dynamics and control; Mars mission analysis; Earth-orbiting mission analysis/debris; Mission analysis; Numerical analysis. Many of the papers are descriptive and do not unduly bog down to elaborate mathematical treatment. Readers interested in probing further on the topics of their interest can access the accompanying detailed bibliography. Majority of the papers contained in the proceedings deal with the Earth and interplanetary mission analysis, orbit determination and allied topics. The remaining three sessions are devoted to spacecraft attitude control with flexibility taken into consideration.

The question of orbit determination has been addressed from time immemorial. The classical techniques which have emerged for over three centuries have relied heavily on innovative approaches for algorithm development and banked less on technological advancements. The modern methods try to bring into their realm latest technological developments such as, say, ground- and spacecraft-borne radars, and system theoretic concepts such as say, Kalman filter. This enhances and cultivates scope for new orbit determination algorithm and their applications to an unlimited horizon. However, the papers in this proceedings address only limited perspective on orbit determination of interplanetary spacecraft, multi-object tracking and Mars gravity modelling (inverse problem of orbit determination from space platform). A pair of papers analyze orbit determination error for spacecraft at L_1-libration point.

The session on celestial mechanics contains two abstracts and six full papers which are equally shared by orbital transfer and orbit analysis problems. The orbit transfer problems address both low and high thrust multi-impulse transfers. They use simplified equation of motion as well as tools that are based on Battin's universal functions, primer vector for fixed time optimality, Brachistochrone problem for bridging gap between high and low acceleration trajectories, respectively. The tools of orbit analysis apply essentially the well-known/time-tested methods to new contexts. In orbit analysis, numerical methods play important role. The two numerical methods are shown to yield high accuracy over a long period of orbit propagation. Montenbruck shows that the Taylor's series integration used for the first time is superior to the conventional methods like Runge–Kutta (R–K) method. However, a companion paper combines R–K with Enke's method and shows it to be more efficient than Cowell's method Multiple impulse Lambert problem and propagation of covariance matrices during rendezvous are useful contributions that may find application in the near future. All but one paper out of eight in the session on optimization deal with the optimal trajectory control. The control is obtained by optimizing the appropriate performance costs *via* methods available in standard textbooks.

System theoretic studies on mission analysis are distributed in three sessions with like-minded titles. Here, the technical papers give vivid description of diverse topics from propulsion system to navigation to mission perspective of orbital transfer and rendezvous to Mars and interplanetary missions to launch missions, to name a few. Even though these papers lack mathematical finesse and innovative theoretical contributions, they can still inspire many a person since they describe several new avenues/possibilities from modern aerospace industry. The reviewer finds that the corresponding 32 papers which form the major portion of part II of the proceedings are the inspiring ones. It is possible that some of the concepts discussed here may find the light of the day while remaining ones may remain in books only.

Three sessions are also devoted to satellite dynamics and control. Two papers formulate the perturbed attitude motion, respectively, due to Mars atmosphere and chaotic attitude maneuver due to oscillation of small perturbing sub-bodies inside a satellite. Survey on time-optimal attitude maneuvers contain many useful references that may be useful to slew control of present multi-mission spacecraft. The feedback linearization is gaining some kind of acceptance at theoretician level in recent times. Spacecraft nonlinear control is one such example During the past 25 years or so, tremendous progress has been made on the understanding of flexible body dynamics and control. In fact, the failure of the first American satellite was attributed to flexibility of four tiny turnstile antennae. Nonlinear control by feedback linearization technique is used here too for control of multipurpose communication satellite INSAT-II as an example by Modi and Ng. Elaborate simulation study amply demonstrates the feasibility of nonlinear control system. Modelling of dynamics of flexible space structure is done in many ways, prominent among them being continuum and discrete coordinate approaches. In the former case, model is represented by a distributed parameter system. In the latter case, large space structure is idealized as an assemblage of multibodies. The tethered satellite systems are special case of flexible spacecraft wherein flexibility of a tether holding the primary and the sub-satellite is prominent. Pioneering work on dynamics and control of tethered system is done by Misra, Modi, Kane and others. Some of the results of the luscious study have appeared in the proceedings

In summary, the papers of this proceedings portray the current trend in global research on spaceflight mechanics. The reviewer finds refreshing the technical papers in the proceedings of both Spaceflight Mechanics conferences that were held thus far. It is a welcome addition to libraries having sizeable readership from aerospace community. However, owing to its price, individuals specially from third world countries like India will find it outside their reach.

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Soil analysis–Physical methods edited by Keith A. Smith and Chris E. Mallins, Marcel Dekker, Inc., 270, Madison Avenue, New York, NY 10016, 1991, pp. 632, $ 180.

Among the different materials one comes across, soil can be termed as one with maximum variability exhibiting complex behaviour. Unsaturated soil consists of solids, water and air. The water present itself exhibits different behaviour depending upon whether it is adsorbed or free, and so on. Soil mass exhibits visco-elasto-plastic behaviour. The behaviour keeps changing due to change in environment, cycles of wetting and drying, etc. Civil engineers and agricultural scientists are among those who are mainly concerned with soil.

It is the basic physical properties like particle size distribution, bulk density, water content, liquid and plastic limits which influence, be it the mechanical properties a civil engineer looks for, or the characteristics an agricultural scientist looks for. Hence these basic properties have been studied by both civil engineers as well as the agricultural scientists.

The treatise consists of thirteen chapters written by different authors. The subjects covered range from particle size analysis, density water content, Atterberg limits, permeability of saturated and unsaturated soils, etc. The penetrometer tests are used to understand tillage, resistance to root growth, etc. The engineering properties of soil are innovatively used to explain the behaviour of soil as an agricultural material.

The authors are to be complimented for explaining the complex soil behaviour in a lucid manner. The treatment is comprehensive and covers the recent developments also. It will serve as a good reference text for graduate students of civil engineering also.

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