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BOOK REVIEWS

What every engineer should know about finite element analysis edited by John R. Brauer, Marcel Dekker, Inc., 270, Madison Avenue, New York 10016, USA, 1993, pp. 321, Price not stated.

The volume has contributions from several experts in various fields of engineering and science on the application of finite-element analysis (FEA) to some example problems in each of their fields. FEA is a powerful numerical technique with sound mathematical basis and is very versatile in use. Its application and use are critically dependent on the evolution of electronic digital processing and the emergence of large and powerful computing systems. This second edition of the volume, has some additional chapters with many original chapters expanded.

The volume contains nine chapters. It begins with a brief historical development of what and why and by whom and when. It is followed by a chapter on basic concepts in FEA. Later chapters cover applications in the areas of structural analysis, design optimization, interaction and model building and processing of results and concludes with a chapter on guide to future in FEA. The volume lays emphasis on applications and supports with illustrative examples. A new chapter, *viz.*, interactive model building and results processing is added which deals with automated pre- and postprocessors. The preprocessor enables the user to idealize and model the real problem into a suitable mesh or grid and generate the necessary large data files for inputting to the main program to carry out further analysis. The postprocessor is again a special program which enables to sift through the voluminous results and number and help to generate easily understandable information like deformed patterns, stress contours, etc. Special tips have been given to identify errors in inputs, general check on equilibria and constraints, etc. The importance of graded mesh in the regions of high-stress gradients is well brought out.

Most of the chapters have been written by people who have used Mac NASTRAN and have compared it with other programs like ANSYS and ABBAQUS. It is written comprehensively and provides material on concepts like P-elements, solvers, etc. FEA was initially applied to structural analysis, to other engineering fields like electromagnetic studies, fluid flows, general design and optimization but was late extended. These applications are also highlighted in the volume.

It is a good book and helps a general engineer appreciate the finite-element methods and provides guidelines for proper application of the method.

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Finite element analysis with personal computers by Edward Champion Jr and J. Michael Ensminger, Marcel Dekker, Inc, 270, Madison Avenue, New York 10016, USA, 1988, pp. 378, $99.75.

This book is intended to be a basic guide for practising engineers who wish to apply finite-element analysis (FEA) to solve day-to-day engineering problems. The reader is presumed to have no exposure to FEA. It has a concise introduction to the field and helps the reader to learn how to

apply this new and versatile technique to their individual situations. The emphasis is on helping the user to solve general engineering problems on own personal computers. The advantages and disadvantages in using personal computer in FEA are clearly brought out. The scope of the method is mainly limited by the amount of memory required and the speed of program execution. Though it is not an exhaustive treatise, it has tried to cover many applications in the areas of structural, fluid, heat transfer and many other advanced topics.

The introductory chapter covers a brief history of FEA, and application for practising engineers. A full chapter is devoted to the hardware requirements in terms of the input/output devices, performance and ability for enhancement of capabilities of the system. Then the fundamentals of FEA solution and verification are covered. The next three chapters deal with problems of structural and thermal analyses and fluid-flow problems. Several examples are presented in each area. The emphasis is on the input of data and output for results by the program. The book deals with the basic engineering problems, the FE model and its data input. After solution of the problem the relevant results are printed out as tables and/or graphical relationships. It ends with a discussion on commercially available FE softwares.

The use of some of the softwares like PCTRAN, IMAGES 3D, ANSYS, SUPERSAP is described and their scope and limitations are clearly brought out. The book also gives relative costs of some of the softwares and compatible hardware. It is very useful for anyone who wishes to establish and run softwares on PCs.

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Analysis of chiral organic molecules by Peter Schreier and Alexander Bernreuther, Walter De Gruyter, Postfach 30 34 21, D 10728, Berlin, 1995, pp. 17+331, DM 168.

Optically active (chiral) organic molecules have been interesting all these years in understanding organic reaction mechanisms and designing enantioselective synthesis. The realization that enantiomers have often different biological activities and the growing insistence of regulatory authorities that single enantiomers of bioactive molecules (drugs, less frequently pesticides) rather than racemates should be developed and marketed have led in recent years to increasing interest in the analysis of chiral organic molecules. While many comprehensive reviews and monographs have appeared on this subject, what has been lacking is 'a concise introduction to and guide through this rapidly developing field covering all facets of methodologies in the analysis of chiral organic molecules'. The book under review fulfills this requirement admirably well.

The introductory chapter describes briefly the importance of studying chiral organic molecules. The second offers a concise summary of basic stereochemical concepts in a simple language. The third chapter is the largest and is devoted to various techniques for the analysis of chiral organic compounds and describes, in two main parts, methods using separation procedures and those not using them.

Chiroptical methods such as polarimetry, optical rotatory dispersion, circular dichroism, etc., used for such analysis are described to begin with in terms of their theory as well as applications. The treatment is logically extended to an account of chiroptical detectors used in liquid chromatographs which are primarily single wavelength polarimeters. The concept of enantiomeric excess is also introduced in this context.

Nuclear magnetic resonance is another tool for the study of optical activity. Enantiomeric differentiation can be achieved using chiral derivatising agents to produce diastereoiosomers or using noncovalent complexation phenomena brought about by chiral lanthanide shift reagents or chiral-solvating agents.

By far the most widely used technique for 'chiral' analysis is chromatography. This long section has subsections treating liquid chromatography, gas chromatography, supercritical fluid chromatography, electrophoresis, planar chromatography and counter-current chromatography. Even stereospecific immuno assay finds mention. In each subsection details such as stationary phases in conjunction with chiral derivatisation or complexation or alternatively chiral stationary phases are discussed in depth with adequate emphasis on the theoretical backdrop.

The noteworthy features of the book are : (i) inclusion of practical examples, (ii) recommendations of columns, phases, etc., (iii) commercial details of chromatographic accessories, and finally, (iv) list of chiral substances analysed by the treated techniques, roughly about 800 in number.

The book has extensive references right through 1994 and is well got up and is practically free of mistakes. A faulty structural formula for N-(3,5-dinitrobenzoyl)phenyl glycine on page 298 (phenyl alanine given) and the use the world of 'hold' for 'held' on page 164, line 2 are almost the only errors that caught the reviewer's attention. The authors deserve the congratulations of a large body of researchers who will find all the information they need in this single volume of 331 pages. At DM 168, the book is affordable by well-endowed institutional libraries, although not by Indian scientists getting their salaries in rupees!

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Properties of silicon carbide by Gary L. Harris, The Institution of Electrical Engineers, Michael Faraday House, Six Hills Way, Stevenage, Herts, SG1 2AY, UK, 1995, pp. 298, £115.

This book is all about silicon carbide, spanning over nine chapters, with contributions by 19 authors. The early observation of electroluminescence in silicon carbide by Marconi scientists during the turn of the century has gone unnoticed for over 50 years. In mid-50s the growth of hexagonal platelets through sub-limitation process has produced a flurry of activities on silicon carbide as a semiconductor material. The editor describes the interests in silicon carbide as 'roller-coaster ride' with many ups and downs. Renewed interest on silicon carbide in the 80s originates from the growth of the heteroepitaxial layers on silicon substrates which brightened the prospects of 'high-temperature electronics'. Numerous applications have been proposed on the basis of electrical and optical properties which include blue light-emitting diodes, high-voltage diodes, X-ray masks, radiation resistance devices, micromachined structures, UV detectors and other optoelectronic devices. Special sectors are envisaged as the end-users such as nuclear reactor electronics, military systems and deep space electronics. Recent examples such as field-effect transistors operating at 12.6 GHz based on silicon carbide are indicative of more types of devices to come out in the near future. However, what limits the technological breakthrough is the growth of large-sized single-crystal boules of specific polytypes. For those who are curious to extend their

vistas in wide band-gap semiconductors, this is a good compendium and a moderately comprehensive update on the materials properties of silicon carbide.

Each chapter deals with specific topical properties and the subtitled sections of the nine chapters are written by different contributory authors during 1993-1995. The introductory chapter is on general properties such as density, lattice parameters of various polytypes, thermal conductivity, acoustic velocity, Young's modulus and other physical properties. Optical properties and paramagnetic resonance studies on impurities and structural defects in SiC constitute the second chapter. Charge carrier mobilities and concentrations, effective mass, band structure and pressure effects on the electronic states are discussed in the third chapter. Energy levels of impurities and deep levels in the forbidden gap region are the subject matter of the fourth chapter. More material is presented in the subsequent chapters on the chemical aspects of SiC which is useful in device fabrication. Thus, surface structure, metallisation and oxidation in the fifth chapter is followed by etching processes under dry as well as wet chemical conditions including electrochemical etching in the sixth chapter. Diffusion of impurities and ion implantation in SiC phases are presented in the seventh chapter. Matters related to ohmic contacts and devices constitute the last chapter. These include the p-n junctions and Schottky diodes, field-effect transistors, bipolar transistors, thyristors and optoelectronic devices. The potential applications of the devices are mentioned at the end of this section.

Besides being a book of data, the chapters are well-documented reviews. Some sections make delightful reading but others are drab. Photoluminescence, electron spin resonance of defects and carrier properties are informative updates. More eloquent are the presentations on crystal growth processes through various techniques. In contrast, the treatment on devices and their fabrication is limited in depth. One has to search around the book for information on electroluminescence in silicon carbide. Equally disappointing is the absence of a systematic chapter on crystal chemistry, stacking disorder and polytypism *vis-a-vis* the recent growth processes. The book certainly is not for fresh students of materials science but for those specialised in the futuristic electronic devices. The printing is impressive; so also the hard binding.

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Space safety and rescue 1992 by Gloria W. Heath (ed.), Vol. 84, Science and Technology Series, published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, Ca 92198, USA, 1994, pp.360, $ 70.

This volume is the series on space safety and rescue contains more than 25 papers presented at a symposium of the International Academy of Astronautics held in conjunction with the World Space Congress in Washington, DC. There are a number of articles on space system safety as well as on crew escape and rescue, but the emphasis seems to be on the application of space science and technology to the disaster management on our planet. It is a little disappointing that only summaries are available on some interesting themes such as impact of space activities on space and earth and space debris. Nevertheless, the position paper on orbital debris in the appendix is very pointed, crisp and well written.

Anyone who has been following these symposia, perhaps, begins with an apprehension if there is any new material at all in this volume that he has not read earlier. The opening paper by

Heath just seems to share this concern with a 25-year overview of safety and rescue symposia, but does not quite allay it.

Safety and reliability analyses becomes rather complex when it comes to modelling human behaviour owing to psychological and emotional factors. The humans are inherently capable of diagnosing and solving new problems that may arise in a mission, but they may not do as well as machines when it concerns prolonged monitoring, vigilance and control. This is tackled in an interesting paper under space system safety. Nuclear thermal propulsion is likely to stage a comeback and therefore the safety and reliability analysis by Sforza *et al.* deserves a special mention. The study with all the compiled data, statistics and references gives an update on the topic.

Amidst a set of 'management' type of descriptive articles on risk management, servicing of Hubble space telescope and the safety strategy for the Hermes, the presentation of the CNES group on a real-time methodology for launchers Debris Footprint comes as a refresher. The concept of shifting all the heavy computation to prelaunch phase and minimizing the real-time computation for rapid control may be worth pursuing in many other related areas.

Crew escape and safety assumes greater importance with the passage of time as man's presence in space is becoming semi-permanent. From the current Mir space station to the proposed space station Freedom, Lunar Outpost and Interplanetary manned vehicle in the next two decades, crew rescue and assured return will become increasingly complex and may drive the vehicle design philosophy. The part dealing with Hermes *vs* Ariane X-capsule and assured crew return vehicles gives vivid description of the many facets of this problem. But many of these themes and the cries for standardisation of rescue and reentry system or international cooperation sound as recalls of earlier volumes. Still, this being an exciting and challenging aspect of human adventure in space continues to absorb the reader's attention.

In the middle of the UN-proclaimed International Decade for Natural Disaster Reduction (Jan 1990–Dec 1999), it is perhaps appropriate that a substantial part of the volume is devoted to space and disaster management, more of the latter. Natural disasters must be viewed from many possible angles each requiring a different approach for warning and relief measures.

Consider, for instance, the time scales involved. Events such as desertification, stratospheric ozone depletion or greenhouse warming occur over decades, crop pest infestations and droughts take months while floods, cyclones and forest fires last only a few days. Still shorter, indeed sudden, are the earthquakes and volcanic eruptions. Many of these have geographical and seasonal preferences. Some of these can be prevented with adequate precautionary steps while in some others only restoration and relief can be provided. In any case, space technology offers several means of dealing with disasters covering prevention, preparedness and relief. Remote sensing, meteorological and communication satellites, many of them dedicated to such missions, play a crucial role in the present-day's disaster management. An irony is that while space science and technology has advanced to a state where these problems can be competently addressed by designing suitable instruments, equipment and satellites, the ground-based preparedness is often inadequate and defeating.

These ideas repeat in many articles and some drift too far away from the orbits of space safety and rescue. The reader may feel compelled to skip many pages. But if one searches patiently, there are new ideas, different viewpoints and technical novelties submerged in the repeating, well known, and sometimes, unnecessary details. A table compiled by Walter (p. 198) serves as a ready reckoner for those interested in the details of satellites meant for disaster mitigation research and applications.

Space safety and rescue as a discipline now encompasses so many subareas that any specialist reader would find only a small part of the volume of interest to him. As usual, the book has been brought out with care that is a tradition of AAS. But, the reader needs to be rescued from texts inundated with short forms and acronyms!

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Chemical engineering (Chemical and biochemical reactors and process control), Vol. 3, Third edition, edited by J. F. Richardson and D.G. Peacock, Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 IGB, UK, 1994, pp.776, £28.50.

The third edition of the popular volume covers the subject of chemical reactor design principles including biochemical engineering fairly exhaustively, and caters to the needs of graduate students and research workers in chemical engineering. The volume covers chemical reactor design, encompassing gas-solid, gas-liquid and gas–liquid–solid reactor systems, biochemical engineering and process control including measurement of process parameters.

The editors must be commended for the reorientation of the part dealing with chemical reaction engineering (CRE). Two chapters of the previous edition have been expanded into four with the inclusion of certain new topics. Some topics like non-ideal flow modelling have been elaborated improving readability. A lot of care was taken to present the legends to figures well with useful information. Figure 2.14 is an example in which the time periods are marked for tracer waves which were not covered in the previous edition. Further, some equations (for example, eqn 2.24) have been modified and presented well.

The editors' choice of the term biochemical reaction engineering is very apt and conveys appropriately the contents of the chapters. Salient features of chemical reactors and biochemical reactors have been described in detail along with problems and differences in the design features of biochemical reactors from conventional chemical reactor design.

Keeping in mind these significant features, the authors have allocated separate sections for enzymes metabolism, and strain improvement methods. Recombinant DNA technology is an example of many advanced topics focused in this section.

The chapter on sensors for measurement and control is entirely new. This chapter probably replaces three earlier ones (Computers and methods for computation, Non-Newtonian technology, and Separation processes). It is impressive as the process control is dealt with in considerable detail and placed correctly ahead of the chapter on process control. Though several books are available on measuring devices and process control, a chemical engineer rarely finds a popular book on sensors and functions of certain basic elements used in measuring devices and controllers. The chapter meets this requirement adequately and enhances the understanding of an engineer in the process line and improves his perception of control devices.

The last chapter is on process control. In the previous edition, this chapter was placed prior to biochemical reaction engineering (BRE). The editors might have thought it appropriate that BRE should follow CRE after the chapter on BRE has been extensively revised and rewritten by in-

cluding new topics, referring and citing recent literature. The chapter is almost double in conten compared to the previous edition. The total rewriting is discernible from the first paragraph an the first figure itself. Inclusion of topics on computer control of process plant is logical and ap preciable in view of the increasing use of computers in process plants. The author who has con tributed the last two chapters has really done a commendable job.

The editors have mentioned in the preface that the chapter on computers and methods fo computation has been removed completely from the entire set. Though we share this view, we feel the need for a worthwhile textbook which deals with computer applications in chemical engi neering written in a systematic way. The editors may cover this material in later edition or bring out a separate volume incorporating numerical methods. It may also contain certain programs written in advanced computer languages in use now. The authors may consider bringing out a volume of solutions to the problems of this volume akin to Volumes 4 and 5.

The chemical engineering community all over the world has accepted the set of six volumes of *Chemical engineering* as a treatise in this branch of engineering. The material is presented clearly and the reader is led systematically from one chapter to another. Overall it is a valuable addition to chemical engineering discipline.

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