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# Book Reviews

**GENETIC ALGORITHMS IN ENGINEERING SYSTEMS** by A.N.S. Zalzala and P.J. Fleming. IEE Control Engineering Series 55, 1997, ISBN 0 85296 902 3, 279 pp. (£45; Hbk).

This book contains ten chapters each by experts in the solution of engineering problems using genetic algorithms (GAs). It starts with a comprehensive survey of GAs which describes various specialist techniques in detail and concludes with a nice example of their use in the multi-objective optimisation of the design of the control system for a high-bypass twin spool turbojet engine. This is a specialists book but it would have been nice if the introduction included more pointers to introductory material or Internet-based material.

The following chapters describe the SAMUEL system, which is shown evolving control strategies, and return to multi-objective GAs. One of the themes of the book is the ability of multi-objective GAs to simultaneously produce many Pareto optimal solutions which the design engineer may then choose between. This is in contrast to other approaches which yield a single result and no indication of other ways conflicting objectives might have been traded against each other.

The later chapters deal with specific engineering applications. The aeronautical theme is returned to in Chapters 4 and 9, with examples of GAs being used to optimise transonic wing shape and jet engine turbine blade temperature control.

Some of the problems of manufacturing are combinatorial and are known to be very computationally hard. Chapter 7 describes the use of GAs to schedule tasks to machines. Results of various techniques on several benchmark job shop scheduling problems are given. While Chapter 10 deals with the problem of optimally laying out components and their interconnections on VLSI chips. Again comparisons of various approaches on benchmark problems are described.

Returning to multi-objective optimisation, Chapter 8 describes the use of GAs to evolve control strategies for large industrial manufacturing robots.

The book says “It is illusory to see GAs as an optimisation tool which can solve any problem with standard operators, after encoding its solutions in a string of 0s and 1s” [page 230]. However, the book describes many non-standard operators and problem encodings and shows that armed with these GAs can, indeed, solve many real-world engineering problems.

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**MODELING AND CONTROL OF ROBOT MANIPULATORS** by L Sciavicco and B Siciliano, McGraw Hill, New York, 1996, 358 pp., ISBN 0–07–057217–8 ($59.47; Hbk).

The stated aim of this book is to present the fundamentals of robot modelling and control in a uniform and rigorous manner. This is achieved through a logical development of the subject over the nine chapters of the book. A brief but clear overview of industrial robot technology is given in Chapter 1, which also highlights important issues in robot modelling and control and introduces a selected bibliography pertinent to the domain. Chapters 2 to 4 are concerned with kinematic and dynamic modelling and with direct and indirect kinematics (Chapter 2), differential kinematics and statics (Chapter 3) and the Lagrange and Newton-Euler formulations of dynamic equations (Chapter 4). Chapters 5 to 7 are dedicated to robot control. Chapter 5 covers the planning of trajectories to obtain a time sequence of joint coordinates as reference inputs to feedback control loops. Chapter 6 describes different closed-loop strategies for controlling robot motion in free space. These include independent joint control and centralised control with compensation for various non-linear effects. Chapter 7 considers interactions between the robot and its environment via contact with the robot end-effector and discusses the ideas of compliance, impedance and constraints and force/hybrid control. Finally, Chapters 8 and 9 cover the more practical topics of actuators and sensors (Chapter 8) and programming and control hardware architecture (Chapter 9). In contrast with Chapters 2 to 7, the treatment in the last chapters of the book is less deep and, judging from the references cited, somewhat dated. The book concludes with appendices on linear algebra, rigid body mechanics and feedback control which provide a good summary of the theoretical background required.

The book is well written and illustrated with many clear diagrams. There are a number of simple examples and end-of-chapter problems which expand on the topics covered.

The work is recommended reading for students following advanced undergraduate or graduate courses in robotics alongside established texts in this relatively mature area of robotics.

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**PARAMETRIC AND FEATURE-BASED CAD/CAM CONCEPTS, TECHNIQUES, APPLICATIONS** by J.J. Shah and M. Mäntylä, Wiley, Chichester, 1995, 619 pp., ISBN 0–471–00214–3 (£55; HBK)

Parametric and feature-based CAD/CAM systems are becoming increasingly common in industry. There is a need for a book that provides an in-depth and comprehensive treatment of the subject independent of particular commercial systems, for use as an intermediate/advanced text by engineering students as well as a reference by researchers and practising engineers. This book fulfils that need admirably. The book comprises twelve chapters divided into five parts taking the reader from background material to future developments in the field. Part 1 (Chapters 1 and 2) introduces feature modelling as part of product modelling and briefly reviews the history and principal ideas of geometric modelling. Part 2 (Chapters 3 and 4) covers the fundamental concepts of features, describes schemes for classifying features and gives an overview of different feature creation methods (interactive definition, automatic recognition and design-by-features). Part 3 (Chapters 5 to 7) deals with applications of features including their use in part and assembly design,

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manufacturability assessment, process planning and inspection planning, and discusses the mapping of features between different viewpoints and sharing of feature data across dissimilar applications to facilitate concurrent engineering. Part 4 (Chapters 8 to 11), which forms almost half of the book, describes the major tools and techniques for implementing feature-based systems and focuses on the most developed implementation of feature-based technology. In particular, the design-by-features techniques (Chapter 8) and feature recognition technique (Chapter 9) of feature creation are re-examined together with a collection of software tools for feature representation, geometric modelling, constraint management and feature recognition (Chapter 10). The feature-based application studied in detail is process planning for machining operations (Chapter 11). Part 5 (Chapter 12) briefly surveys research on product modelling approaches such as top-down assembly modelling and function-based modelling for preliminary design and configuration modelling for product design, and discusses the role of feature-based techniques in the development of these approaches. Three appendices conclude the book by giving basic mathematical concepts, an example of a boundary data structure and listings of the functions for a dynamic interface between geometric feature-based applications and geometric modelling kernels.

The book is clearly written and presented. Each chapter includes review questions and a bibliography to facilitate study of the subject.

As mentioned above, the book will serve well both as a student text for a course on CAD/CAM and as a referenece for researchers and practising engineers.

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**CONTROL SYSTEM DYNAMICS** by R.N. Clark, Cambridge University Press, Cambridge, 1996, 509 pp., ISBN 0–521–47239–3 (£50; Hbk).

This is an introductory textbook on classical control from an experienced teacher and author. The book has 15 chapters. Chapter 1 gives the rationale for the work and outlines its scope. The remaining chapters follow the general pattern of mathematical modelling, time and s-domain techniques, frequency response techniques and advanced topics. Chapters 2 through 7 are concerned with the modelling and analysis of different types of physical systems. Chapter 2 covers the mathematical modelling of mechanical systems, while Chapter 3 deals with electrical systems and Chapter 4 develops models for electromechanical and electrohydraulic systems. Chapter 5 introduces the ideas of state variables and the state-space model of a linear system. Chapter 6 describes the derivation of the time response of a system from its model and Chapter 7 details the use of the Laplace transfer function of a system for this purpose. Chapters 8 to 10 discuss the analysis and design of closed-loop systems in the Laplace domain. Chapter 8 gives the basic notions of feedback systems. Chapter 9 describes the root locus technique for stability analysis. Chapter 10 deals with the design of compensators and robust systems able to reject disturbances as well as controllers for non-minimum-phase plants. Chapters 11 through 14 are devoted to the use of frequency response techniques for feedback system analysis and design. Chapter 11 defines the concept of frequency response, relates the frequency response function to the transfer function and gives various graphical methods of representing the frequency response function. Chapter 12 describes the Nyquist criterion for stability analysis while Chapter 13 explains the analytical techniques of Bode and Nichols. Chapter 14 re-visits the problem of compensator design, this time using frequency response methods. The final chapter, Chapter 15, briefly discusses advanced topics including the analysis of linear multivariable systems, discrete-time systems and nonlinear systems. The book also contains five appendices providing information on physical units, algebraic and trigonometric formulae, Laplace transforms, the Routh stability criterion and normalised time and frequency response curves for first, second and third order systems.

The book is clearly written and amply illustrated with good line diagrams. End-of-chapter problems form an integral part of the text, giving the reader the opportunity to apply and extend the principles described as well as derive new formulae needed in subsequent chapters. A helpful addition in a future edition would be a section on block diagram or signal flow graph manipulation which is usually found in introductory books in this area.

The book should appeal to students following a first course in control systems requiring a gentle break-in to the subject. It could be prescribed as background bibliographic material for those studying robotics but without an initial grounding in control engineering.

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**DICTIONARY OF ACRONYMS AND TECHNICAL ABBREVIATIONS (for IT, Industrial and Scientific Applications),** by J. Vliestra; Springer, Berlin, 1997, vii + 692 pp. (DM 78.00; £29.50; $49.95).

This collection of acronyms and technical abbreviations contains over 32,000 entries. It is thus the most comprehensive and up-to-date compilation of such terms. The items are arranged in alphabetical order and relate to the following areas: Automatic control; Administration and accounting; Computer-aided applications such as CAD, CAE, CAM, CAT, CAI, etc. . .; Electronics:Logistics and Planning; Manufacturing; Networks, including the Internet and *WWW*); Information technology; and Telecommunications. In addition, the dictionary also contains symbolic names of organisations and institutions relating to the above subjects. Furthermore, the book lists abbreviated names of symposia, conferences and workshops of relevance to the subjects, as well as the standard two-letter country codes that refer to the country acting as host to national organisations.

Because of the proliferation of acronyms and abbreviations in scientific papers, often without explanation as to their meaning, this volume is a valuable guide to readers trying at times to understand the sometimes *exotic* terms used in their abridged form. The author acknowledges the fact that he was unable to trace nearly 20% of acronyms used in the scientific literature and advertisements! This compilation is a most valuable addition to the scientific literature, especially in Information Technology.

J. Rose

**ATOM-PHOTON INTERACTIONS: BASIC PROCESSES AND INTERACTIONS** by C. Cohen-Tannoudji, J. Dupont-Roc and G. Grynberg, Wiley Interscience, Chichester, UK, 1998, xxii + 656 pp., index (£34.95).

This paperback edition looks at a wide range of phenomena arising from photon-atom interactions and the related theoretical models. It draws upon the model used for quantizing the electromagnetic field in the Coulomb-gauge presented in the authors' previous volume, 'Photons and Atoms-Introduction to quantum electrodynamics', which is also briefly presented in an appendix to this volume.

The advantages and disadvantages of the various theoretical techniques are presented in such a way as to enable the reader to make an informed choice of method most appropriate for a particular problem. Alternative approaches and mathematical

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proofs are often included in complements to the chapters, and remarks are appended to the end of sections which help clarify the physical consequences. Physical examples are carefully worked through, and a substantial part of the book is given over to exercises with worked solutions.

This is a highly theoretical, mathematical book, but the reasons for each step are carefully explained, everything precisely defined and the physical consequences regularly referred to. Its relevance to readers of *Robotica* is not at all clear, being of interest primarily to theoretical physicists and not suitable as an introduction to the field.

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**ABSORPTION AND SCATTERING OF LIGHT BY SMALL PARTICLES** by C.F. Bohren and D.R. Huffman, Wiley Science Paperback Series, Chichester, UK, 1998, xiv+530 pp., List of references, index (£34.95; pbk).

Since it was first published in 1983, this book has been an essential volume for those involved in research in which the scattering of electromagnetic radiation is important. The *Fortran* routines helpfully provided at the back of the book have no doubt been the foundation of many computer models of scattering processes since then, saving many researchers many hours of hard work.

This is a professional reference book, pitched for the most part at a level above that of undergraduate teaching. The writing style is clear and highly accessible, charmingly light-hearted in places and conveys an infectious enthusiasm for the subject lacking in most text books. Clear physical explanations are given throughout, making it possible to follow easily in sections where the mathematics are difficult.

Using classical electromagnetic theory and concepts of linear optics, it deals with scattering theory, the bulk properties of matter and the combination of these in three sections. Theoretical formulations are examined for applicability and compared to experimental data where possible. Written largely for practical physicists, there is something in this book for almost everyone: solid-state and atmospheric physicists, astronomers, biophysicists, electrical engineers and probably more.

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**DIFFRACTIVE OPTICS FOR INDUSTRIAL AND COMMERCIAL APPLICATIONS,** edited by Jari Turunen and Frank Wyrowski, Akademie Verlag and J. Wiley, 1998, xiv+426 pp., index (£65).

This comprehensive and timely book opens with a detailed explanation of the fundamental principles of diffractive optics as well as the appropriate design and fabrication techniques. This first chapter was written by the editors (without resort to heavy mathematics) and is followed by thirteen chapters that each concentrate on a particular subject in the field of diffractive optics. The authors of these chapters are all specialists and are currently researching in the design and application of diffractive optics in the U.K, U.S.A, Sweden, Germany, Finland, Liechtenstein and Switzerland!!

For example Chapter 3 by G.M. Morris and K.J. McIntyre of the University of Rochester, U.S.A. presents a state of the art review of optical system design with diffractive optics. Chapter 10 by A. Kamshilin of the University of Joensuu, Finland is unique in the book as it is devoted to dynamic optical elements which are sensitive to light rather than permanent diffractive optical elements. Chapter 14 by F.S.M. Clube of Holtronic Technologies, Switzerland, explains the very latest manufacturing techniques using Holographic Microlithography.

This book has the rare distinction amongst new textbooks in that it really is up to date. I strongly recommend it to those scientists and engineers already working in the field as well as those who wish to enter it.

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