J. Indian Inst. Sci., Mar.–Apr. 1999, **79**, 165–180.

BOOK REVIEWS

Guidance and control 1995 edited by Robert D. Culp and James D. Medbery. Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California, CA 92198, 1995, pp. 600, $120.

The proceedings of the Eighteenth Annual ASS Rocky Mountain Guidance and Control Conference is presented in this volume. The publication maintains the tradition of publishing state-of-the-art research in a simple narrative style. The six chapters contain papers presented in the sessions on: Advances in guidance, navigation and control; International; System integration; Guidance and control storyboard displays; Precision pointing in the 1990s and Recent experiences. The proceedings contain judicious mix of papers from academics and industry.

The first session contains seven papers on navigation, guidance and control. These papers are intended for research managers in spacecraft industry since they discuss at length the managerial issues relating to estimation and guidance, with the exception of two papers on control, which also have minimal mathematics. With the aid of reference provided in these publications, one could possibly have better appreciation of advances in navigation guidance and control of spacecraft. The second session comprises international papers with their subject focusing on multinational cooperation in navigation and control. Here, six papers deal with an improved navigation algorithm for onboard attitude determination, the use of magnetometers and magneto torquers on small satellites, advanced sensor management of infrared space observatory, GN&C system for the international space station Alpha, and a review on the GN&C interface standard. The third session dwells on various elements of system integration pertaining to satellite missions. These papers report the activities related to development and system integration cost and time, and are useful for mission designers.

In recent times, the storyboard session is becoming popular since the technical papers are presented in an informal setting and with large scope for detailed discussion on technical content. Of the 20 papers presented in this session, six have found their way to the proceedings. These papers present useful account of integrated view on hardware and software issues on guidance and control components. The fifth session on 'Precision pointing in the 90's' exposes recent developments in various control configurations, hardware and software for space-based precision pointing. The five papers in this session overview the technological evolution and discuss pointing configurations used on the Airborne laser, Pluto fast fly by spacecraft, Hubble telescope and Alpha lamp integration program. The traditional sixth and final session on 'Recent experiences' features lessons learnt from recent programs and experiments. Six papers on Maneuver performance and control; Technical discussion on Hubble servicing mission; Results from Microcom Autonomous Navigation system (MANS); Delta Clipper-Experimental (DC-X) GN&C system; and ANIK E2 attitude control logic are included under this session.

The papers presented in this proceedings are carefully selected and edited by well-known and experienced editor Prof. Robert D. Culp and his colleague. The proceedings has once

again shown that it embodies vast amount of knowledge within a short space. These papers are useful to researchers and practicing space scientists.

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Guidance and control 1996 edited by Robert D. Culp and Marvin L. Odefey. Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California, CA 92198, 1996, pp. 744, $120.

The proceedings of the Guidance and Control 1996 conference continues the tradition of providing timely information on research and developments taking place in the forefront of aerospace engineering pertaining to the theme topic. Under the expert editorial work of Prof. Robert D. Culp and his associate, 45 specialty papers have been published under six sessions.

The first session on Autonomy and innovation in guidance and control has eight papers on Spacecraft autonomy; Topex/Poseidon autonomous maneuver experiment; Integrated autonomous navigation; Autonomous orbit control and spacecraft orbit determination; Gyro noise reduction for precision spacecraft pointing; Analysis of star-tracker estimation capability and gyro users perspective. As the next millennium approaches, autonomous spacecraft operation devoid of ground control has become the need of the hour so as to increase system reliability and utility, and to reduce cost and weight. Autonomy also implies goal-orientedness. The first five papers are devoted to autonomous navigation and control. The last three papers of this session are however slightly outside the main theme even though these components are needed for the next generation of spacecraft. The second session on the Application of test beds to spacecraft guidance and control is in a way logical extension of the session on 'system integration' included in the previous (1995) G & C conference. All the five papers are presented in an easy-to-understand narrative style. Even though these papers do not focus on their themes with sufficient mathematical depth so as to be directly used by researchers, the breadth of coverage certainly makes them useful to many.

The third session on University initiatives in spacecraft navigation, guidance and control (NGC) contains six technical papers by well-known personalities and their co-authors and are useful for researchers in aerospace and allied sciences. This topic has been introduced as a new agenda to this conference. The session features papers on Robust control of flexible space structures; Hardware emulation systems for control system research and education; Guidance and control of air-breathing launch vehicle; Kalman filtering in orbit determination; Error propagation in orbital mechanics; and Navigation, guidance and control in education. The first five papers are written for persons with good scientific bent of mind. Next 12 papers are selected for publication out of 22 presented at the customary story-board session on guidance and control. These interesting papers discuss in detail the design and development issues related to spacecraft components such as Miniature dual Earth sensor; Miniature inertial measurement unit; Advanced space-borne computer module comprising fault-tolerant control proc-

ess module; Satellite inertial reference systems; Generic platform for attitude and orbit control system usable in diverse satellites missions; and Miniature analog sun sensor. Vibration control of spaceborne flexible beam-like structures is the subject of two papers in this session.

The fourth session also contains six papers on a new emerging area of smart structures. These papers dwell on: Active vibration isolation of spacecraft instruments; Broadband vibration isolation system using stiff actuators; Microprecision interferometer test bed with fringe tracker control system; Shape memory-actuated spacecraft mechanisms such as release devices; Gimbal and deployment hinge; Robust damping treatment of metal matrix composite space structures; and Development of neural network for suppression of a multi-tone disturbance. These papers contain useful technical/practical information necessary to conduct experimental research that is not commonly available in many journal publications. Hence, these are supplementary materials to the researchers. The traditional sixth and final session on 'Recent experiences' contains seven papers on Analysis of flight experiences from different missions on the performance of navigation; Guidance and control; Vibration isolation flight experiment; Attitude and orbit control system; Middeck active control experiment and attitude determination and control.

The 1996 proceedings is a very good collection of papers that has lots of practical utility. The papers are representative of vast research being carried out worldwide and indicate the level of advancement made in this ever-challenging field of aerospace guidance and control.

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Guidance and control 1997 edited by Robert D. Culp and Stuart B. Wiens. Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California, CA 92198, 1997, pp. 458, $120.

The proceedings of the Twentieth Guidance and Control Conference presents 26 papers arranged in groups of five sessions instead of customary six sessions. The papers of the storyboard session on guidance and control are not printed this year since the emphasis of these presentations is on demonstration. The five sessions comprise two traditional topics on guidance and control (first and last sessions) and three new topics on orbital phenomenon, natural radiation effect and precision optical control.

The first session on Autonomy and innovation in guidance and control has four papers on attitude determination using GPS combined with inertial system, low-cost control system for telerobotic satellites, Topex/Poseidon autonomous maneuver experiment (TAME), and attitude control and survival of the STARDUST spacecraft during the Wild-2 comet passage. It may be observed that INS and GPS have many complementary characteristics in terms of systematic and random errors, mode of operation, need for initialization, accuracy, and drift. Integrated GPS and INS system takes advantages of these properties. The authors also suggest scope for future work which will be of interest to researchers in this field. Similarly, the low-

cost attitude control system designed for telerobotic spacecraft can definitely find use in many small satellites on the anvil. As the authors point out, more and more spacecraft need high level of autonomy and specially when the number of satellites increases in large proportion as the number of satellite users proliferates in this era of information technology. Detailed exposure to TAME is definitely useful to new entrant satellite builders. The last paper in the first session gives a candid detail of a very intricate interplanetary mission for collecting sample particles from a comet approximately 2.6 AU from the Earth and returning back to Earth with the samples. The fifth and last session on 'Recent experiences in guidance and control' has seven papers detailing experiences gained from practical missions/experiments. Despite great strides made in theoretical modeling and analysis techniques for aerospace vehicles, one needs experimental validation of new technologies so as to make them acceptable. The seven papers discuss In-flight performance of reaction wheel assembly; Performance of MSX guidance and control system; On-orbit anomalies in the Earth sensors; Experience gained from Space Shuttle inertial unit and GPS receiver; Results of attitude control stress test and flight evaluation and refinement of 'NEAR' guidance and control system. These representative papers, though form a tiny fraction of lessons learnt from actual missions, are extremely helpful.

Unlike the proceedings of previous years, the mid-two new sessions on Orbital phenomenon and Natural radiation effects deal with issues that influence the guidance and control system as external sources of disturbance and they are not part of spacecraft guidance and control. A good number of publications on these topics are normally found in Spaceflight mechanics and Astrodynamics conference conducted by AAS and AIAA. The papers presented here are of slightly lower caliber than what is found in Guidance and Control conference proceedings. The papers in the fourth session on precision optical control has six interesting papers and clearly demonstrate the high quality of technical advancement made by the US space industry.

The proceedings of the 1997 Guidance and Control conference contains a large number of valuable papers and a few run-of-the-mill-type publications too. Notwithstanding this, the proceedings is certainly useful to researchers worldwide.

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Guidance and control 1998, Vol. 98, edited by Robert D. Culp and David A. Igli. Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California 92198, USA, 1998, pp. 706, $75.

The papers are classified under several major areas of general and specific interest to the aerospace scientist working in the broad area of guidance and control. The section on "Advances in guidance and control" features expository papers on autonomous maneuver planning and implementation for small space missions having high autonomy with special emphasis on the Topex/Poseidon Autonomous Maneuver Experiment (TAME): Attitude control requirements

for NASA's Earth Orbiter-I mission; MIT's spacecraft-type test bed used for studying structural dynamical responses during large slew maneuvers and for designing tracking controllers; Control law design for remote-sensing of the Earth's surface using large oscillating mirrors; Detection of launched missiles from space during their boost phase by tracking the missile plume; Usage of control moment gyros to improve the agility of satellite remote-sensing maneuvers of satellites in low-Earth orbits; and A case study on the Orbview-2 satellite with fixed thrusters using LQR control theory.

The section on 'Commercial space applications' has a collection of papers that addresses issues of practical interest. For example, in one of the papers, modifications carried out to make an inertial measurement unit suitable for space applications and mass production are described. Another paper describes the design of an attitude determination control system for remote-sensing applications. A third paper describes a software tool that enables easy use of the ESA-pointing error handbook. Yet another paper describes NASA's autonomous navigation system with GPS position, velocity, time, and attitude capability for use in the international space station crew transport vehicle. The last paper in this section gives a comprehensive overview of the progress achieved in designing low-cost high-performance fiber-optic gyroscopes.

The section on 'Launch systems' has a collection of papers on guidance and control systems for various space vehicles. The K-1 reusuable launch vehicle, the X-33 technology demonstrator, the X-34 reusable technology demonstrator, and the SMV (space maneuver vehicle) are covered here. Ring laser-based space navigation systems are covered in one paper while the last paper in this section gives an account of the recent developments in the Titan class of launch vehicles.

The section on 'Storyboard displays' has a collection of papers discussing optimal attitude estimation, design of a 32-bit onboard computer and low-cost star camera, fiber-optic gyroscopes, attitude control magnetometers, an object-oriented architecture for distributed spacecraft simulations, among other topics of interest.

The section devoted to 'Sensor and actuator phenomena and modeling' has papers on sensor technology for autonomous formation flying of a triple spacecraft system, reaction wheel performance modeling, vibration isolation study, pulsed plasma thruster systems for attitude control, dynamically tuned gyros, Earth sensor data, and landing radar for planetary missions.

The last section, 'Recent experiences in guidance and control', has several interesting papers on diverse topics including NASA's Near-Earth Asteroid Rendezvous (NEAR) mission where the spacecraft Discovery flew within 1200 km of the asteroid Mathilde in June 1997, pointing accuracy of star trackers, use of GPS on small satellites, attitude control in microsatellites, and sub-orbital flight of a missile for technology demonstration purpose.

On the whole, the collection of papers in this volume is an excellent representation of the current research and development effort in the area of guidance and control of spacecraft and related systems. As is normal with this series of conference proceedings, the papers are of

high quality and are of great importance of aerospace scientists and engineers as they offer a rare glimpse into the heart of the technology used in space-related systems.

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DEBASISH GHOSE

Space safety and rescue 1996 edited by Gloria W. Heath. Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California 92198, USA, 1998, pp. 460, $ 60.

The papers in this volume constitute the proceedings of the 29th International Symposium of Safety and Rescue, held at Beijing, China, in October 1996. The papers in the volume are categorized under several sections—the first two sections are broadly related to space safety and rescue operations and risk aspects of these operations, and three remaining sections are devoted to risk arising from space debris.

The Challenger disaster a decade ago made the space scientists intensely aware of the paramount importance of space safety, even at the cost of commercial viability. The changing perceptions over the following decade encouraged scientists, engineers, and technologists to look for practical solutions to problems without compromising on safety aspects. The papers in this volume are representative of this philosophy.

The section on 'Safety and quality of space programs' has several papers dealing with Space Shuttle safety. The paper by Greenfield discusses ways and means of maintaining Space Shuttle safety by implementing meaningful performance metrics. Whitehair and Wolfe discuss the US government's space system acquisition policy and its impact on risk management procedures while accounting for budgetary constraints. Lacau in his paper discusses whether 'faster' and 'cheaper' contradict 'better' and how effective quality control can ultimately lead to successful missions. The paper by Peercy *et al.* is jointly written by American and Russian space scientists and addresses the operating principles involved in safety and risk management programs for mixed crew space flights such as the Mir–Shuttle docking missions. Notwithstanding the unintentionally hilarious operating principle ("Both Russian and American members are governed by the basic desire and intent not to damage each other's crew or hardware."!), the paper presents an interesting insight into safety measures undertaken in complex space operations. The paper by Malfroy and Brochard–Runavot is on the joint French–Russian Mars 96 project having an Orbiter and two small stations for scientific experiments.

The section on 'Risk management and assessment' has a paper by Peercy *et al.* presenting an overview of Space Shuttle safety risk management program and its major components such as risk identification, risk assessment, and risk mitigation. Among the other papers are Laulheret *et al.* addressing risk management and RAMS (reliability, availability, maintainability, and safety) in satellite production, Tatry *et al.* discussing the utility of RAMS to reusable sin-

gle-stage to orbit launch vehicles, and Esmieu addressing risk management issues in small satellites that are characterized by low-cost and short development schedule. Marcoux and Woop present the European initiative to develop standards for space products and advocate risk management as an integral part of project management. Hyatt and Rosenberg discuss the important issue of risk arising out of software usage and development in the context of NASA's space systems. Skramstad's is yet another paper on software risk management in the Norwegian public sector.

The sections on space debris present the changing perceptions to this very real threat, given the increasing density of man-made space objects in orbit around the Earth.

The section on 'Space debris measurement and modeling' has an interesting paper by Ganeshan and Ananthasayanam that models space debris distribution in the low-Earth orbit by modeling the fragmentation process that leads to debris creation. The paper by Yasaka *et al.* models the debris environment in geosynchronous orbit. The paper by Klinkrad and Tejedor discusses the European Space Agency initiative in creation of a database on space debris called DISCOS.

The section on 'Space debris risk analysis and protection' has papers by Yasada *et al.* that present the Japanese experience on the observation system for space debris, Tu and Zhang which discusses a debris cloud model that takes into account solar activity, Crowther *et al.* discussing debris hazards to satellite constellations, Xi *et al.* discussing a vulnerability model of satellites that yields an effective reliability analysis of debris impact, Alby addressing the issues of risk limitation and protection, Battaglia and Rossi presenting an overview of the Italian space debris-related activities, and the last paper by Levin *et al.* discusses the effect of meteor storms on human space flights.

The last section on 'Space debris mitigation in space transportation' has four papers on debris mitigation measures for the Ariane launcher (Bonnal and Naumann), the Japanese standard for debris mitigation (Kato), evolution of space debris population (Bendisch *et al.*), and issues in managing the geostationary orbit (Loftus *et al.*).

The volume provides an excellent and in-depth coverage of the current thinking on specific issues related to space safety and rescue and the serious threat posed by natural and man-made space debris in space.

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Advances in stochastic models for reliability, quality and safety edited by W. Kahle *et al.*, Birkhauser Verlag AG, Klosterberg 23, CH-4010 Basel, Switzerland, 1998, pp. 380, sFr. 148.

This enlightening volume presents the main contributions to a workshop on stochastic models of reliability, quality and safety that was held in Schierke, Germany, in 1997. This well-known

workshop is a part of a series of meetings organised every two years by the Society of Reliability, Quality, and Safety.

The book contains 24 well-written and excellently organised papers on the theory and applications of stochastic models in the areas of reliability, quality, and safety. The topics have been chosen with care to provide a balanced overview of a broad spectrum of topics. The contributors are quite well known for high-quality research in their own research specialties and naturally one anticipates reading such a rich collection of papers with great expectations. The book certainly does not belie these expectations.

The volume is very useful and timely and the contributions are authentic. It will prove to be of immense use to researchers, mature professionals, and graduate students in the areas of stochastic modeling for reliability, quality, and safety of complex systems. The book more than fulfills the purported objective of providing a cosmic view of the significant trends and recent developments in the area.

The book is organized in four parts, each containing a number of chapters, where each chapter deals with a specific topic or methodology or a recent contribution of substantive value. The four parts are:

Part 1: Lifetime analysis (6 chapters)

Part 2: Reliability analysis (8 chapters)

Part 3: Network analysis (4 chapters)

Part 4: Process control (6 chapters)

Each individual chapter has at the end a list of useful references.

Part 1 comprises six chapters on recent advances and theoretical underpinnings of lifetime analysis, which is a fundamental issue in reliability studies. The topics include: generalized Linnik distributions for lifetime modeling; lifetime estimation using the notion of acceptance regions; failure–repair models under censoring; parameter estimation in renewal processes; risk theory in the presence of heavy tails; and three-parameter Weibull and Frechet models.

In Part 2, the contributors discuss important issues in reliability theory and reliability analysis. The contributions range from classical topics such as maximum likelihood estimation in k-out-of-n systems to emerging topics such as damage processes, Markov-additive processes, and Brownian motion in reliability modeling. All the articles here have an authentic review followed by a bird's eyeview of the current research.

There are four chapters in Part 3 which is devoted to network analysis. The first chapter presents a simple algorithm for computing approximately the reliability of arbitrarily large networks. The second looks into reliability analysis of flow networks. The third is on approximations for nonlinear mechanical systems, while the fourth presents a unified approach to the reliability of recurrent structures using a graph-theoretic framework.

The six chapters in Part 4 are devoted to issues in process control. The topics include: testing for existence of a change point in a specified interval; integration of statistical process control and engineering process control in discrete manufacturing processes; controlling a process with three

different states; CUSUM schemes and Erlang distributions; average delay of control schemes; and tolerance bounds and *cpk* confidence bounds.

It is certainly a challenge to cover all significant trends and developments in the area in a single volume like this one. For example, performability (which combines performance of a system with reliability) which has been a leading topic of research in the last 15 years in this area does not find a place in this volume. Similarly, the recently emerged theory of large deviations has a lot to offer for reliability modeling. This and some related topics such as rare-event simulation have been left out. Notwithstanding these omissions, the book certainly embodies an extremely valuable collection of authentic articles. The editors have done a commendable job of organizing this volume in a logical way. Researchers and graduate students working in this area will find it a rich repository of recent advances in the area.

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Internet economics by Lee W. McKnight and Joseph P. Bailey, The MIT Press, 55, Hayward Street, Cambridge, MA 02142, USA, 1998, pp. 525, $ 20.

The Internet and the World Wide Web have dramatically transformed the landscape of computing applications and have become an integral part of day-to-day life through applications such as electronic commerce, home shopping, remote banking, video on demand, etc. With new applications, new users, and new connections, the Internet has become an important medium for communication, information dissemination, and electronic business. Thus, Internet has emerged as an important element of the global economic system.

Internet economics deals with economic analysis of Internet transactions. Pricing of Internet usage and transactions is now a growing area of concern for members of the technical, business, academic, and user communities. There is now a critical need for developing and deploying acceptable metrics for economic analysis of Internet usage and transactions. The issues of Internet economics have, however, proven to be difficult to grapple with and in order to understand how economics might contribute to the self-sustaining growth of the Internet, a Workshop on Internet Economics was held at the Massachusetts Institute of Technology in March 1995. The successful workshop brought to light, for the first time, a wide spectrum of topics in the area of Internet economics that were pursued by researchers all over the world. The current volume is a collection of 20 articles contributed by some of the leading participants of this workshop.

The book is in six parts:

Part 1: Introduction to Internet economics (1 article)

Part 2: The economics of the Internet (4 articles)

Part 3: Interconnection and multicast economics (3 articles)

Part 4: Usage sensitive pricing (6 articles)

Part 5: Internet commerce (4 articles)

Part 6: Internet economics and policy (2 articles)

The editors, McKnight and Bailey, have written a cogent introduction to the topic of Internet economics (Chapter 1). This chapter introduces the methods, issues, and alternative approaches to the study of Internet commerce.

Part 2 reviews the basic economic qualities of the Internet from different perspectives. The first chapter in this part introduces and answers many questions that are commonly asked about Internet economics. The second chapter on the economics of layered networks addresses issues of Internet economics from an architectural perspective. The third chapter provides an empirical case study to show how usage-sensitive pricing policy can be deployed on the Internet. The fourth chapter in this part traces the history of pricing policies in network-based systems and explores their relevance for Internet economics.

Part 3 explores the economics of interconnection between Internet networks and also the economics of multicast services. The first chapter in this part discusses interconnection agreements that exist in today's Internet. The second chapter presents four different models of Internet interconnection agreements. The third chapter discusses the pricing of shared data streams from multicast services.

In Part 4, there are six articles which present new thinking and research on Internet resource allocation and pricing. The articles discuss the trade-offs in three varieties of pricing, flat-rate pricing, usage-sensitive pricing, and transaction-based pricing. The chapters offer a fresh look at pricing policies from all important perspectives.

The articles in Part 5 explore the connections between the emerging discipline of Internet commerce and Internet economics. The articles argue that research on Internet commerce, including payment, insurance licensing, security, etc. will have a great impact on the way Internet pricing policies evolve.

The final part (Part 6) has two articles on policy issues related to Internet commerce. The first chapter explores the economic benefits of supporting public goods for further development of the Internet. The second chapter focuses on market failures of the Internet and makes a case for regulation.

It is certainly a challenge to cover all significant trends and developments in the area in a single volume like this one. However, the volume certainly embodies an extremely valuable collection of authentic articles. The editors have done a commendable job of organizing this volume in a logical way. In my view, this volume represents the best current thinking on Internet economics and is a must-read for Internet researchers, Internet service-providing community, Internet policy makers, and business community.

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Fundamentals of statistical mechanics by B. B. Laud, New Age International (P) Limited, Publishers, 4835/24, Ansari Road, Darya Ganj, New Delhi 110 002, 1998, pp. 260, Rs. 145.

The author's earlier work entitled *Introduction to statistical mechanics* published in 1981 was fairly well received by the academic community. The author has used the feedback received from students and colleagues effectively to eliminate a few deficiencies of the earlier work and to extend the coverage of the topics to a number of new areas of applications. The present book is really a second edition of this earlier work. It is naturally quite readable and largely free of errors. It is broadly aimed at the MSc-level students in physics; others like chemistry or engineering students can also profitably follow the book.

The book starts with an introduction to the ideas of probability and statistics so as to make it self-contained. This has enabled the author to introduce in Chapter 3 Maxwell distribution of velocities in a perfect gas as an example of probability arguments. The ideas of micro- and macro-states are next introduced from where microcanonical, canonical and grand canonical ensembes are developed in Chapter 5. Statistical thermodynamics of gases is developed on the basis of canonical ensemble ideas of Maxwell–Boltzmann statistics (Chapter 6). The incorporation of quantum mechanics into statistical considerations leads to Bose–Einstein and Fermi–Dirac statistics (Chapter 8). The ideal Bose and Fermi gas systems are described in the next two chapters. Phase equilibria under diverse conditions are considered in Chapter 11. The simple kinetic theory of transport phenomena is given in Chapter 12, followed by the more general theory in the next chapter. The book has three small appendices. Short answers are then given to a few select problems which have been given at the end of each chapter. A bibliography of a number of good textbooks on the subject is added as the last item.

While the coverage is fairly conventional for a textbook at this level, the manner of presentation is the feature which is likely to endear it to students. All the items have short descriptions and simplified derivations, with equation numbers drawing attention to critical steps. Each chapter has a small number of questions, most of them involving simple calculations. As mentioned earlier, answers to a few of these questions have also been provided. Thus, a student, who diligently follows the text, will get an understanding of the subject. One who works through the problems will definitely get considerable familiarity with the applications of statistical mechanics. Figures in the text will aid in following the description given in the text.

The book has evolved out of teaching of physics to students. The approach and the selection of topics have this background. Applications to other subjects like chemistry, biology and engineering are at best indicated in outline. Students of these subjects would require the guidance and interpretation of the teaching staff to follow the text. Students of physics can in principle use the book for self-study. In this sense, every student has some useful material in the book and can base it as a springboard to learn about the more advanced and detailed discussions.

Every teacher has his or her pet ideas about the selection of topics to be covered in a book. It would be unfair to criticize a book on this score. The author, based on his experience in teaching physics to students in a university, has arrived at his own selection of topics. Overall,

it is well written, keeping in mind the Indian system. Being a revised edition, it is relatively free of slips or mistakes.

If the review is short, it is mainly a reflection of the good treatment given to a conventional theme. It was a pleasure to read the book written with the students in mind. The paperback edition is modestly priced. It is strongly recommended to individuals as well as libraries.

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Control systems by Naresh K. Sinha, New Age Publishers (P) Limited, Publishers, 4835/24, Ansari Road, Darya Ganj, New Delhi 100 002, 1998, pp. 488, Rs. 195.

This is the third edition of the book, first published in 1994 and reprinted in 1995. The changes in this edition appear to have been completed in 1996, but the book is published in 1998. The book is designed to meet the needs of students taking one or two courses in control systems.

The book consists of 14 chapters and 5 appendices. The author has also produced a floppy (obtainable from the publishers at a nominal cost) containing a number of programs to remove the computational burden from the student.

Chapter 1 is a brief introduction. It gives a brief history of control theory. Two simple control system examples are given to introduce the concept of feedback and error. Chapter 14 is an epilogue giving a bird's eyeview of the present trends in control theory.

Chapter 2 is concerned with developing transfer function models of physical systems. Methods of writing differential equations for mechanical and electromechanical systems are explained. Block diagrams are introduced and then simplification is discussed. Mason's rule is discussed considering only the block diagram representation without bringing in signal-flow graphs.

Chapter 3 is also concerned with modeling. Here, state–space models are considered. State–space models are developed for a number of physical systems and the relation between transfer functions and the state–space models are brought out clearly. Similarity transformations and methods of evaluating the state transition matrix are dealt with.

Chapter 4 is a small chapter dealing exclusively with the characteristics of closed loop system. Devoting a separate chapter to discuss issues such as sensitivity to parameter variations, disturbance signals, etc. shows the mind of a good teacher who is attempting to draw the attention of students to these fundamental issues, which many a time are overlooked.

Chapter 5 deals with the performance of control systems. The standard test inputs are introduced and the transient response of the first- and second-order systems to these inputs are

discussed. The steady-state error in the performance is considered and its evaluation is discussed.

Chapter 6 starts with the definition of stability and covers the Routh–Hurwitz criterion and its application. A welcome addition in the Kharitonov polynomials to handle parameter uncertainty.

Chapter 7 is concerned with the root locus method. In addition to discussing the properties of the root loci, the chapter covers a simple design example to show its application. Also discussed is the sensitivity of the roots to parameter variation and also to the open loop pole and zero locations.

Chapter 8 deals with frequency response plots. Bode plots are discussed. Method of evaluating transfer function from frequency response plot is discussed. Alternate frequency response plots such as polar plots and log-magnitude vs phase plots are also discussed.

Chapter 9 deals with the application of frequency-response plots. First, Nyquist criterion is introduced. Its application to assess the stability of the closed loop system is considered. Characterizing the relative stability in terms of phase and gain margins is explained. The method of determining frequency response of the closed loop system using polar plot of open loop transfer function and constant M circles is clearly explained.

Chapter 10 deals with the design and compensation of control systems. Typical compensators are introduced first. Then frequency response-based methods are described followed by root locus-based design. Two additional features in this chapter are pole placement approach and application of PID controllers.

Chapter 11 introduces digital control. Starting with the advantages of digital control, the chapter introduces zero-order hold, concepts of stability, frequency response and root-locus methods for discrete time systems. The other topics introduced are steady-state accuracy, Nyquist's criterion and design of digital controllers. The author has tried to cover a large number of concepts within a single chapter and hence the treatment has been only very basic.

Chapter 12 is concerned with time-domain methods. Key concepts of controllability and observability are introduced. State variable feedback for designing in the time domain is discussed. The chapter also introduces observers, their use in state feedback and also a basic formulation of optimal control.

Chapter 13 deals with nonlinear systems. The chapter first introduces common nonlinearities and the concept of stability of nonlinear system. Three methods of studying nonlinear systems, i.e. linearization, describing functions and phase-plane approaches are described. The chapter ends with a brief exposition on Lyapunov's direct method of stability analysis.

The appendices on Laplace transforms, matrices and z-transforms make the book self-contained.

The contents of Chapters 1 to 10 (sometime excluding Chapter 3) form the material for the first course in control systems in most of the Indian universities and this book would be ex-

tremely useful for such a course. The contents of the second course on control systems is not that uniform across the universities and I do not think there are courses which can be taught using only the last three chapters of the book.

I do not think the book has been written in such a way as to make the use of computers mandatory in teaching this course from the book. I am not making this comment in a negative sense because the practice of integrating computer use in course teaching is not widespread as yet. The floppy containing the programs was not made available to me and hence I am unable to comment on the utility of these programs. It would have been helpful if the authors had marked the problems in the exercises which are preferably solved using the software provided.

I see that a lot of care has been taken in producing the book. The figures are very clear and properly sized. The equations are well laid out and the book is very pleasing to read. I did not see many typographical errors either.

In conclusion, this is an extremely useful book for students taking their first course in control systems.

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Singular integral operators and related topics edited by A. Bottcher and I. Gohberg, Birkhauser Verlag AG, Klosterberg 23, CH-4010 Basel, Switzerland, 1996, pp. 324, sFr. 128.

This volume contains the proceedings of the joint German–Israeli Workshop on Linear One-dimensional Singular Integral Equations held at Tel Aviv University in 1995. The contents are divided into 12 chapters. Even though a variety of topics (inverse scattering problems for differential operators, distribution of zeroes for orthogonal functions, etc.) are discussed in this volume, a bulk of the chapters is devoted to the study of the following one-dimensional Cauchy singular integral operator:

$$(S_\Gamma f)(t) = \frac{1}{\pi i}\int_\Gamma \frac{f(\tau)}{\tau - t}d\tau.$$

Here, Γ is a closed rectifiable Jordan curve in the complex plane. (If $\Gamma = \mathbb{R}$, we easily recognize that S_Γ is nothing but the classical Hilbert transform.) The novelty here is that S_Γ is considered with 'bad' coefficients.

Generally speaking, there are different approaches to the study of singular integral operators with variable coefficients of the above kind: complex variable method (which applies particularly to one-dimensional singular integral operators), real variable method (which can handle multi-dimensional operators), method of pseudo-differential operators (which is based on Fourier analysis), etc. The approach followed in this volume is different and based on Banach algebraic techniques. Among researchers working in the area of partial differential

equations and numerical analysis, the latter method is not known as much as the previous methods.

One of the first known properties of S_Γ is the following: If Γ is a Carleson curve, then S_Γ is a bounded operator on $L^p(\Gamma)$, $1 < p < \infty$. In addition, if w is a weight function in the Muckenhoupt class $A_p(\Gamma)$, then S_Γ is bounded on $L^p(\Gamma, w)$. In view of applications, further properties of a bounded operator which are of interest are the following: invertibility, Fredholmness, semi-Fredholmness, spectrum, numerical approximation, etc. There are several articles in this volume which investigate the above properties using Banach algebraic techniques.

What are the advantages of the Banach algebraic method? For instance, pseudo-differential operator method usually requires the coefficients to be very smooth. The relaxation of smoothness is not an academic exercise. Indeed, the media behave in a qualitatively different way depending on the smoothness of the coefficients representing them. Analysis of these new phenomena is an active field of modern-day research. One of the virtues of the Banach algebraic method is that it is capable of capturing these new features. Presentation of some of them is one of the highlights of the volume under review.

In order to better appreciate the contents of the volume, it will be necessary to recall the main steps of the method. Consider the Banach sub-algebra A of the algebra of all bounded operators on $L^p(\Gamma)$ generated by S_Γ and the algebra from which the coefficients are taken. This algebra quotiented out by compact operators often admits a nontrivial centre. This offers the opportunity of applying *local principle*, one of the basic tools of the method. Properties such as invertibility, Fredholmness are localizable. Roughly, the principle states that an element is invertible in the quotient algebra if it is so in all associated local algebras. (Recall Fredholmness is nothing but invertibility in the algebra quotiented out by compact operators.)

The next step is to analyze the invertibility question in each of the local algebras. For instance, if the local algebra is generated by two idempotents then the so-called Two-Projection Theorem applies. Roughly speaking, it defines a family $\{f_t\}_{t \in T}$ (called *symbol*) of representations of the algebra into the algebra of 2×2 matrices. One can read off the invertibility of an element by checking whether the same is true of the matrices $f_t(.)$ for all t in T. Further, the indexing set T is an object closely related to the algebra.

If the coefficient α is constant then the algebra is generated by a single element and is commutative in particular. In such a case, the above two steps coincide with the classical results in Gelfand's theory of commutative Banach algebras.

The above programme has been carried out in a variety of cases. Some of the classical results concern the case of piecewise continuous and quasi-continuous coefficients. This volume reports on some recent developments in this area. They include the following:

1. Suppose that Γ is a composed curve instead of being simple. Then we need a version of N-Projection Theorem with $N > 2$. This is a nontrivial problem because if an algebra is generated by three idempotents or more then it need not possess a symbol of any finity order, as examples show. Thus, there is a qualitative difference between 2- and 3-idempotent cases. However, by requiring that generators satisfy certain additional rela-

tions, one can associate a symbol of finite order and corresponding calculus can be developed.

2. Consider $P_\Gamma = \frac{1}{2}(I + S_\Gamma)$. This is a projection because $S_\Gamma^2 = I$. Define $L_+^p = PL^p(\Gamma, w)$. The Toeplitz operator $T_\Gamma(a)$ induced by the coefficient $a \in L^\infty(\Gamma)$ and S_Γ is

$$T_\Gamma(a): L_+^p \to L_+^p, \quad f \mapsto P_\Gamma(af).$$

Numerous question on S_Γ with coefficient a can be reduced to the study of $T_\Gamma(a)$. Analysis of $T_\Gamma(a)$ is carried out assuming Γ is the unit circle and considering oscillating coefficient a in various classes not considered so far: u-, almost, and semi-almost periodic, etc.

3. Apart from the effects of coefficients, the effects of Γ are of great interest. This is analyzed by taking a to be piecewise continuous and Γ to be arbitrary Carleson Jordan curve. The spectrum of $T_\Gamma(a)$ is determined and the corresponding symbol calculus is developed.

4. Generalization of symbol calculus for singular integrals with operator-valued coefficients is also carried out. This requires the introduction of notions of quasi-continuous functions and compact operators in the operator-valued setting.

5. The above ideas (local principle, symbol calculus) widely used in operator theory are also applicable to problems in numerical analysis. Indeed, a few chapters of this book are devoted to approximation of singular integral equations. One can develop a symbol calculus for algebras of approximating sequences of operators. The symbol gives information on the stability of the sequence which is an essential ingredient in the convergence analysis of approximate solutions.

The above description hopefully gives a glimpse of the contents and their importance. Unlike many conference proceedings, this is more focused on the themes mentioned above. However, it should be kept in mind that this is not a textbook. Several of well-known results are assumed and only recent developments are described. The level of description is quite high and can be understood by specialists in operator theory. In conclusion, this book is highly recommended for mathematicians working in Banach algebras and will be of general interest for workers in partial differential equations and numerical analysis.

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Published by N. M. Malwad, Journal of the Indian Institute of Science, Bangalore - 560 012;
Typeset Creative Literati Pvt. Ltd., Bangalore - 560 033. Tel-Cum-Fax : 5462698;
Printed at Lotus Printers, Bangalore - 560 044. Tel : 3380167, Fax : 3357378