

BOOK REVIEWS

An agenda for the 21st Century edited by Rushworth M. Kidder. The MIT Press, 55, Hayward Street, Cambridge, Massachusetts 02142, USA, 1987, pp. 216, \$ 14.95. Indian orders to Affiliated East-West Press Pvt. Ltd., 6, Roselyn Gardens Apartments, 20/1A Barnaby Road, Madras 600 010.

"If you can look into the seeds of time, and say which grain will grow and which will not, speak then to me" and speaking to us are the twenty-two wise men and women of the world, in this book *An agenda for the 21st century* put together by Rushworth M. Kidder, a professor of English and a Monitor reporter, editor and writer. The fundamental agenda item is only one as Richard Von Weizsacker, President of Federal Republic of Germany, insists and that is to preserve nature, creation and ourselves. Our concern for nuclear armaments, population, environment, technology, North-South gap, education and morality is an expression of our desire to keep our home, our earth clean and well equipped so that we can live forever. So, what are the Do's and Don'ts for ensuring immortality?

Nuclear armament, no doubt, scores the highest on the don't list. The West hopes to preserve peace perched on a nuclear stockpile. Do we want to huddle together like frightened sheep? Perhaps not, but what about the spin-offs of defence-based research? "And the statement that since you invest in Star Wars, you will do your toothpaste better is also total rubbish" anguishes Abdus Salam. More men and materials have been lost in the 160 wars waged with conventional weaponry since World War II. "If such senseless waste has not received as much attention as the nuclear disarmament, it is because these wars were thought of as far away in developing countries," General Olusegun Obasanjo, the former head of state of Nigeria, draws our attention. And it is this indifference that has initiated a North-South divide. AIDS received attention when it migrated from Africa to America. The decline of rain forests is not seen as a global problem because it is in a far-away land. But the environment does not need visa to cross countries. Chernobyl has no political boundaries. Disappearance of rain forests is not a problem of Brazil or Malaysia, only. The North cannot insulate itself. Turmoil, hunger, military government, rebels and revolutions will rudely shake up the North from its ecstasy. The need of the 21st century is the global planning and cooperation instead of erratic 'reaction to crises'. Not cancer, but the foreign polices are the number one killer. Former President Jimmy Carter laments the lack of planning in America due to "President Reagan's philosophical aversion to planning". Decimating forests, land erosion, population explosion are some of the major issues which demand global attention.

"Population, when unchecked increases in a geometrical ratio. Subsistence only increases in an arithmetical ratio" states the principle of population. World population is

expected to double in the next century and 90% of this extra 5 billion people will be in Asia, Africa and Latin America. The repercussions will transcend all boundaries. The need is to acknowledge that "your problems are really my problems." "Can the United States go on forever being a democracy inside and an empire abroad?" asks Mexican novelist-diplomat Carlos Fuentes.

"We are a rubbish-creating society and some of the rubbish, we can't even destroy" observes Lloyd Richard, actor-director and Dean of the Yale School of Drama. Destroy this earth and escape to other planets, how irresponsible! Or may be not, for "who really can't take it can leave and colonize space" suggests Freeman Dyson who sees himself in the role of Richard Hakluyt, the 16th century champion of England's colonizing efforts.

What do we need to solve these problems? "A cold, clear rational thinking" that made the moon walk possible (and the laxity in which caused the Space Shuttle disaster) beams Mortimer Adler, the gem in the crown of the Aspen Institute for Humanistic Studies. And the only resource we need is the education of the people. The knowledge must mature into wisdom. We have developed the means of communication but have forgotten the message. The concern for the lack of humane qualities flows throughout the book like subsoil streams. Sissela Bok of Brandeis University has a single item agenda "the trust" because it is as essential as the ozone layer. Andrei Voznesensky, one of Soviet Union's foremost poet needs "art and poetry like vitamins". The future of mankind lies in a value system based on morality satisfying rationality. Materialism has but a very limited role in human happiness. Technology is only a helping hand. The human element is the master.

The anxiety for the North-South divide reflects the rationally altruistic attitude of the intellectually inclined individuals. But what about the man-woman divide? "The society is geared towards domination and manipulation rather than to compassion" says Shuichi Kato. Hanna Gray, the President of the University of Chicago, is the only one to warn that "issues facing women cannot be entirely solved for them by society". Can somebody tell me in which century, the one half of the humanity will not live in fear of the other half?

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On aesthetics in science edited by Judith Wechsler. Birkhauser, Boston, Inc., 675 Massachusetts Avenue, Cambridge, MA 02139, USA, 1988, pp. 180, \$38. Indian orders to Springer Book (India) Private Ltd., 6, Community Centre, Panchsheel Park, New Delhi 110 017.

On aesthetics in science is a seven-fold way to the understanding of the dynamics of the act of creativity, a crash course of the unification of wisdom and beauty in sciences. In the introductory chapter Judith Wechsler, the editor, raises a basic issue: Does aesthetics play any role in the pursuit of science? Products of arts like music and painting are

judged by their aesthetic appeal to our senses. A product of science is evaluated for its utility, for its ability to explain the observed and its power to predict the yet-unobserved. Is it important, the way one arrives at the product? We learn early that science is pure reasoning detached from all subjectivity. Are there many ways of describing the truth? Can a mathematical equation be beautiful? Does reason have to rhyme? "Uniqueness results when the two combine, the truth and beauty". The choice is dictated not by the problem but by the aesthetic taste of the scientist. Bohr, Dirac, Heisenberg, Einstein, Poincare and others have been quoted abundantly to emphasize the crucial role of beauty and aesthetics in the process of creation but perhaps Keats has said it all with "Beauty is truth, truth beauty — that is all ye know on earth and all ye need to know".

The second chapter 'Structural hierarchy in science, art and history' is by Cyril Stanley Smith, a metallurgist by profession. The author finds that the earliest evidence of knowledge on the structure of metals comes from art museums for "discovery derives from aesthetically motivated curiosity", like why the sky is blue, why a rainbow exhibits colours always in the same order or why the relativistic equations must be covariant. Although preservation of form is the essence of all recognizable structures, the system does admit change at some hierarchical level. Chance nonconformity, in the form of a vacancy or a defect in a crystal lattice or in the form of suspension of tradition in a social system, sows the seeds of change, challenge and creativity. The virtues of this discordant note, of this 'odd one out' are extolled by Philip Morrison, a physicist, in his essay on 'Broken symmetries'. Two electrons with equal spin are indistinguishable. At another level, during its evolution, a system, conserves energy because one time is like another, conserves momentum, because one position in space is like another, conserves angular momentum because one axis direction, is like another. Symmetry simplifies and simple is beautiful. But symmetry needs infinite time and space. The observable world is finite. We can see only so far. The human life is only so long. We "trade off error against time". We need the odd one out. We need change for being, for growing. An asymmetry, an imperfection, a broken symmetry offers a practical solution. Imperfection does not offend our aesthetic sense for it focusses perfection, the odd one out strengthens our ideal of alike. A uniformly pumping heart spells life, a missed heart beat can enclose an eternity. The familiar is smug, the unknown is exciting. The sky is at its bluest with the white clouds wandering about, demonstrating the Bocanian principle: "There is no excellent beauty that hath not some strangeness in the proportion".

In the next chapter, Arthur I. Miller recounts the development of quantum theory and emphasizes how it necessitated a change of habit. The virtues of visualization, the method of modeling, the convenience of continuum had to be abandoned in order to break fresh ground. Sanctity was conferred on intuition, abstraction and metaphors. The ramp had to be replaced by rungs. The indeterminacy determined. The duality of wave-particle, of continuity and discontinuity compelled Heisenberg, Born, Schrödinger and Einstein to take sides until the aesthetic sense of Bohr encompassed all in his principle of complementarity, the illustration for which was provided through quantization of electromagnetic field by Dirac and of matter field by Jordan, Klein and Wigner. Thus, visualization was regained, the abstract acquired body and everything was in its place once again.

Seymour A. Papert. Professor of Education takes us to discovery island where truth waits on beauty. The truth here is synonymous with mathematics, with logic. It is reassuring to know that if you have good taste, you can be a mathematician, though according to Henri Poincaré, good taste is something one is born with. You cannot learn it. Analytical ability is useful, aesthetic guidance is essential for the act of creation. Out of the many ways of solving a problem, some are more beautiful than others. Route, not the destination, is the distinctive feature. It is not what you do but how you do that puts you apart. For example, how do you prove that $\sqrt{2}$ is an irrational number? Two ways have been shown, one uses the step-by-step deductive reasoning and the other a flash of insight about the properties of numbers. But here, unfortunately, all aesthetic is completely lost due to printing errors. On page 114 (line 2) $2 = p/q$ should be replaced by $2 = p^2/q^2$; lines 8 and 9 should read "We can read off from $p^2 = 2q^2$ that p^2 is even. It follows that p is even" instead of "We can read off from $p = 2q$ that p is even. It follows that p is even". Also on page 21, "-constant angle of refraction of light of different wavelengths" is inaccurate. What the author actually wants to say is that the relationship between the angle of refraction and wavelength is constant. While discussing ice and water, one has to use extra caution with the term volume (page 21).

The next essay on 'Darwin's Tree of Nature and other images of wide scope' by Howard Gruber, a psychologist, directs our attention to the worlds beyond simplicity. We have been preoccupied with the symmetric, simple and serene. Is the complex not beautiful? Charles Darwin's recognition first of the multiplicity of natural species and then the desire to organize it in a few laws is taken as a case study of the duality that dwells in the scientific process. If simple is preferred to complex, then why does a forest appeal equally or in fact more to our sense of pleasure and wonder than a well-groomed garden. Noise woke up music in Mozart. The unpredictability of Darwin's tree contains the germs of future, a way of perfection. The rose is beautiful, the rosehip is beautiful and the rose bush is beautiful. Complex imagery is equally productive and aesthetic.

And last, but not the least, pops up the question of intuition vs rationality which the author Geoffrey Vickers, a social scientist, sees in the roles of creator and critic. Of course, there have been instances when intuition (ether) held up the progress of science and there are instances where complex molecular structures were decoded in dreams. Intuition and rationality are complementary. They feed on each other. One cannot think in vacuum. Intuition may germinate the thought which then grows under the vigilant eyes of rationality. Since the perception is personal, intuition is individualistic, here then enters the aesthetic sense in the discriminatory processes. Artists learn the value of aesthetics early in their career. The scientist, on the other hand, appears to become aware of aesthetics and beauty late in life, when they have time to look back and reflect over the struggles and rewards. That aesthetics and beauty are the selection rules that must be satisfied in addition to the symmetry laws and boundary conditions while solving a physics problem, well my teachers never told me so! Are we bashful of admitting sensuality in science?

Toward a livable world: Leo Szilard and the crusade for nuclear arms control edited by Helen S. Hawkins, G. Allen Greb and Gertrud Weiss. The MIT Press, 55, Hayward Street, Cambridge, Massachusetts 02142, USA, 1987, pp. 499, \$ 50. Indian orders to Affiliated East-West Press Pvt. Ltd., 6, Roselyn Gardens Apartments, 20/1A Barnaby Road, Madras 600 010.

This is the third and final volume of the Collected Works of the Hungarian-American scientist Leo Szilard, known most widely perhaps for the letter that he persuaded Einstein to write to President Roosevelt, in 1939, urging that the US build the atom bomb. Szilard's scientific papers, numbering all of 29, are in the first volume; the second, called *His version of the facts*, contains his recollections and correspondence on the development of nuclear weapons before and during the Second World War. The present volume deals with his post-war efforts to control the weapons whose construction he had so successfully advocated earlier. It contains 93 items, made up of articles, notes, memoranda, letters to editors and correspondence with political leaders and scientific colleagues; and there is an excellent introduction by Barton J. Bernstein.

What the volume brings out clearly is that Szilard was primarily an 'ideas man', with a much keener sense of the future than his colleagues. He took out a patent on nuclear fission sustained by a chain reaction five years before the first was discovered and nine years before the second, at a time when Rutherford considered the idea "merest moonshine". Only a few months before Einstein's letter to Roosevelt Niels Bohr had deemed the bomb "virtually impossible to achieve". However, as the bomb Szilard had advocated became a reality six years later, he was also among the first to argue against its use, e.g., in Japan. Soon after the war he transformed himself to a one-man lobby for peace, inventing diverse clever schemes for controlling nuclear weapons, all meticulously described in this volume. He successfully persuaded Kennedy and Khrushchev about the usefulness of the now-famous hot line, and was one of the co-founders of the Pugwash conferences. When he was not thinking of the bomb he helped conceive the Salk Institute (as his mind turned away from physics to biology), and got a reluctant Wigner to write his classic work on group theory. His uncanny ability to see ahead is also illustrated by his flight from Germany to Austria, just one day before the Nazis clamped down. He agreed in 1935 to shift to New York (from England where he was then working) one year before the outbreak of war, and did also in 1938 having correctly foreseen the coming cataclysm in Europe.

The impression one gets from this volume is of a man of boundless energy who, having once adopted a cause, would work ceaselessly to promote it by all means at his command—persuasion, debate, correspondence and, if necessary, intrigue. Szilard must be the only scientist whose Collected Works include a long section devoted to exchanges with a foreign leader like Khrushchev. These are particularly revealing, and also amusing, as the subject under discussion alternates between grave issues facing the superpowers and the intricacies of loading new blades on a Schick razor (gifted by S to K)! There are also letters to Stalin, Kennedy, Senator Humphrey and (once again *via* Einstein) to Nehru; and debates with Teller, Sir Benegal Narasinga Rao and others.

All this incessant hobnobbing with the high-and-mighty of the world and the tireless effort to save mankind from itself was not without cost to Szilard. His academic career was often in jeopardy (recall he had only 29 scientific papers to his credit!). When the Institute of Radiobiology and Biophysics (which had provided him a professor's position after the Manhattan project) collapsed, even a recommendation from Einstein was ineffective. He was eventually a reluctant professor of social sciences, whose other practitioners had little use for him. In fact, the only peaceful time he seems to have had was for a few months in La Jolla just before he died at the age of 66. Even his personal life was unsettled: he never had a home after 1919, lived mostly in hotels and clubs, and married secretly in 1951 (continuing to live separately from a devoted wife who is one of the editors of this volume). Szilard seems to have been a nomad at heart.

But he had other troubles as well. He was a difficult scientific colleague. For all the pains he took on the bomb he was considered a security risk. General Groves, the Director of the Manhattan project, felt so annoyed with Szilard (who, the General reasoned, had after all never played baseball as a boy) that even internment was recommended. Puzzled Army operatives tailing Szilard filed grim reports (from which extracts are reproduced in the volume) on his odd behaviour, in which we easily recognise only the good old absent-minded professor.

I believe that the key to understanding Szilard's preoccupations may well lie in his engineering background, which he had acquired in Budapest and Berlin as a student before doing his Ph.D. in physics. We see this in his many patents and inventions (including a liquid-metal pump refrigerator devised with Einstein). At Chicago, he tried hard to improve relations between the university and industry, having had strong contacts with the latter as a consultant. Whether it was constructing the bomb or controlling it, playing war or promoting peace, his mind was always seeking the technological or methodological 'fix' that would solve the problem. Many observers noted his passion for detail in the proposals he made for ensuring global peace: I see here the attention to microdesign characteristic of the good engineer. He seems to have been a brilliant inventor who was not quite content to be one, working among brilliant physicists whose single-minded pursuits he could not quite share.

Coming from a Europe that had dominated the world in the previous century, he found the Americans naive (in one piece on Thucydides he notes how the Greeks, with a more mature political system than the US, could still not avoid the suicidal Peloponnesian War): he spoke frequently of how there was no market in Washington for his wisdom and how "scientists and engineers do their job too well and statesmen do not do theirs nearly well enough". His adopted country in turn thought *he* was naive, or too clever: Einstein accused him of overestimating the role of rational thought in human affairs.

The volume is most interesting to browse through, for it shows what one determined individual can do. Oppenheimer is supposed to have quoted a well-known verse from the *Gita* when he saw the first nuclear explosion at Alamogordo. I feel sure Szilard would have preferred a different but equally well-known verse from the second chapter, for he

says "Let your acts be directed towards a worthy goal, but do not ask if they will reach it" — Szilard's version of *karmayoga*.

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Guidance and control 1987 edited by R. D. Culp and T. J. Kelly. American Astronautical Society, 1987, pp. 622, \$ 75. Orders to Univelt, Inc., P.O. Box 28130, San Diego, CA 92128.

Guidance and control 1987 is the Proceedings of the Tenth Annual Rocky Mountain Guidance and Control Conference held at Keystone, Colorado, U.S.A., and sponsored by the American Astronautical Society. The Conference series, which began as a local and informal exchange of ideas and reports of achievements, was formalized in 1977 and has turned out to be an event to which the entire US guidance and control community looks forward to each year, and which generates wide interest among the relevant community elsewhere in the world.

The Guidance and Control series typically contains five or six major sections, each containing several articles. The themes of the major sections change from year to year to cover topical aspects. The articles are diversified, covering conceptual, analytical, software and hardware aspects and include review and mission-oriented papers.

The first section in the current volume covers innovative approaches to guidance, navigation and control through seven articles. A report on the hardware developmental aspects of a charge-coupled device tracker for spacecraft provides a glimpse of the state of the art — in fact, futuristic developments — in high-precision, automated trackers for star and targets for high-precision instrument/spacecraft pointing and advanced navigation applications.

Further exposure to ultramodern guidance and control hardware is provided through several excellent articles scattered through out the volume. The 'productization' possibility, for space applications, of a fibre-optic rotation sensor (FORS) with long life and high accuracy, is discussed by Loven Stokes in an article in the second section of the volume. The FORS is being considered to be highly promising candidate for aerospace applications of the future for the added advantages of low-power consumption, potential for high reliability, absence of moving parts, no 'g' sensitivity and rapid start-up. This revolutionary sensor scores on many points even over a very advanced device such as the ring-laser gyro (RLG); it requires no high-voltage supplies and no mechanical dither (with associated vibrations), and has the potential for lighter weight, longer life time and lower cost than RLGs. In fact, FORS is claimed to be the only gyro technology yet with truly no moving parts. These facts should be of direct interest to the aerospace community in India which is currently engaged in several large and advanced projects. We seem to be trying hard to catch up with the RLG technology and applications. Before we

commit major resources in this direction and plan our future aerospace systems based on this device, we should perhaps pause and take a hard look at the scenario.

Another advanced hardware application in astronomical context is an integrated star sensor/tracker capable of very fine pointing and attitude control. With steadily decreasing cost of deploying payloads in earth orbits, the number of planned missions has risen steadily. Because of this increase in number, as well as in the sophistication of space payloads and their functioning, more and more missions will make increased demands on the pointing accuracy required of the attitude control system. Fine pointing and control systems are therefore subjects of intense topical interest. This article is a status update in one aspect of such an important area. An article on fine guidance sensor and star selector servo system for NASA's Hubble space telescope is another contribution in the same direction. A broader area is covered by a descriptive article on gyro technology, covering several classes of gyros, from the control moment gyros for spacecraft attitudes management to the state-of-the-art fibre optic gyros that can be used to sense the angular change in spacecraft attitudes. Further development in the area of gyroscopes is an update on a very modern (rather futuristic) gyro experiment—the stamped relativity gyro experiment—to detect the very feeble relativistic effects on gyro precision in micro-gravity conditions.

Besides the advanced hardware topics, a major area of emphasis in the volume is on computer applications in aerospace guidance and control. An interesting insight is provided by an article on fault protection design for unmanned interplanetary spacecraft. A hierarchic control architecture for intelligent structures is reported, covering the development of an echelon hierarchic feedback architecture applicable to structures with widely distributed sensors and actuators. The interesting concept here is that the control functions are divided into global and regional control with clear hierarchic relationship. A brief report on the activities of the Martin Marietta Denver Aerospace Robotics Development Laboratory covers aspects of robotics in general and space telerobotics in particular. Specific experiments in the area of manipulator technology are touched upon. A key to the teleoperation research there is a reconfigurable control section.

Detailed aspects of space robotics and teleoperation are covered through six articles in an entire section. A very interesting exposé is a telerobot flight experiment covering control issues in gravity-less conditions of space. Another article describes a new seven-degrees-of-freedom space telerobot concept which addresses teleoperations and robotics needs of the future space programmes. Mechanical operators with high degrees of freedom may lead to unacceptable performance under certain environmental conditions, and the important aspect of the stability of remote teleoperators has been analysed. An overview is provided of the advanced control concepts for space robotics pursued at the Stanford Aerospace Robotics Laboratory. The space telerobotics program of Caltech's Jet Propulsion Laboratory also gets coverage. An analytical exposition is made of the interesting case of planar manipulators with elastic links.

Test *versus* simulation has been a running battle in the development of complex aerospace systems. Each approach has its merit, and the two are in any case used together in most programmes, though the extents vary. It is not uncommon for one or the other

route to be taken based on dogmas, personal preferences and historical reasons. In this context, the section devoted to test *versus* simulation in the development of guidance and control system is a very relevant one. Also this section contains some articles covering aspects of a very important project from the current American point of view—the strategic defence initiative (SDI).

A very demanding application covered in this category is the precision tracking and pointing of directed energy weapons. A comprehensive set of space experiments is described which is designed to demonstrate the acquisition, tracking, pointing and fire control technologies required for directed energy weapons. Contrasting with this experimental approach is a simulator, based on ground, for rapid retargeting and precision-pointing systems. No matter how well a precision-pointing system is designed, serious performance degradation can occur due to vibration transmitted from other equipment. Two articles provide light on advanced vibration isolation systems: one dealing with active electro-mechanical isolation and the other with magnetic isolation. Simulation and closed-loop testing of the attitude and articulation control subsystem for the Magellan Venus mapping mission and of large space structures are other important topics discussed.

A major asset of the Guidance and Control series is its collection of articles describing actual experiences gained from flights of real space systems. In the current volume, there are six such articles. However, in a marked departure from the other sections of the volume, and indeed earlier volumes in the series, which are merely all-American in their focus and content, three of these six articles describe the European experience—EXOSAT, SPOT and the OTS/ECS Telecom I spacecraft. Perhaps this is due in part to the relative lull in the US launchings caused by the well-known setbacks, and in part to the gaining all-round vigour of the European space programmes.

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Computer-aided design and manufacture (Third edition) by C. B. Bešant and C. W. K. Lui. Affiliated East-West Press Pvt. Ltd., 104, Nirmal Tower, 26, Barakhamba Road, New Delhi 110 001, 1988, pp. 410, Rs. 98.

The aim of this book in the authors' own words is "to introduce the subject of computing as an aid to design and manufacture, and to take the reader through from the basics of computers to their application in real engineering design and manufacture". Further: "Particular emphasis is given to the reader who has very little knowledge of computing and for those who become sufficiently interested to write their own software whether it be for graphics, robots or other systems used in manufacture. The aim has been to give the reader some ideas from which new work might also grow".

If the reader's ideas about what to expect from this book conform to the above aims, this book turns out to be quite nice reading. It is intended not for the specialist, but for

readers looking for a good overview of the vast area of computers and their applications in the mechanical sciences. The authors have demonstrated commendable versatility in discussing such wide-ranging topics as: computer hardware, graphics and geometric modelling, drafting, finite element method, numerical control, CAD system hardware and organization, industrial robots, flexible manufacturing systems, process planning, computer-aided management, and industrial CAD/CAM implementation and its implications; all within four-hundred and ten pages! They have done reasonably well in their efforts.

As regards presentation, the diagrams, tables, and photographs are all quite up to the mark. A little abundance of figures may be noticed, but that would probably be helpful for the intended readers. References are rather few and include mostly industrial manuals and well-known textbooks. Including a few key references to recent research publications would have been more useful in giving the reader "some ideas from which new work might also grow".

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Power electronics by P. C. Sen. Tata McGraw-Hill Publishing Company Limited, 4/12, Asaf Ali Road, New Delhi 110 002, 1987, pp. 1031, Rs. 60 (subsidized).

Power electronics by P. C. Sen is a welcome addition to the literature on power electronics. Power electronics is an area which covers wide ranging topics, and it is not an easy job to make justice to all of them. In recent years, there have been rapid changes in many areas like power semiconductor devices, control techniques, converter topologies, etc., and any book has to run the risk of being outdated in a few years in this aspect. A chapter-wise review of the present book is given in the following paragraphs:

Chapter 1 deals with the characteristics of semiconductor devices. The treatment is centered mainly around diodes and thyristors (SCRs). While the treatment of silicon-controlled rectifier is really exhaustive, there is hardly any mention of the characteristics and related aspects of the recent devices like GTOs, power MOSFETs and transistors.

Chapter 2 deals with thermal aspects and protection of power semiconductor devices. The topic on heat transfer could have been made a little more effective by means of worked-out examples. Protection aspects are covered in good detail. While, theoretical aspects of fuse choice are covered in great detail, one or two worked-out examples on choice of fuses would have made greater impact on the student. (There seems to be a minor printing error on pp. 177-191, as these pages carry the title of chapter 3).

Chapters 3 and 4 cover the single- and three-phase (uncontrolled) rectifiers. There is a section on the design of LC filters and three-phase power transformer for rectifiers, illustrated by means of detailed examples.

Single- and three-phase controlled rectifiers are discussed in Chapters 5 and 6. The treatment is exhaustive. The controlled rectifiers are well illustrated by detailed design examples. The examples also cover the selection of power devices and interphase reactors.

Chapter 7 covers the triggering circuits for phase-controlled rectifiers. These control circuits are an important aspect of power electronics controls. This chapter could have been made more fruitful by giving some practical circuits with complete design of triggering circuits. For example: in P 560, there is an SCR gate-triggering circuit, which the author has used often in the succeeding sections and chapters, but one cannot use the circuit as there are no design details.

Chapter 8 conveys detailed description of ac- and dc-voltage regulators. Both manual and automatic regulators using servos are covered in detail. Single-phase controlled ac regulators are covered with various types of loads. Three-phase ac regulators are covered exhaustively for various loads along with firing circuits. There is a good coverage of ferroresonant voltage stabilizer. SCR-controlled dc voltage regulators are treated towards the end of this chapter.

Chapter 9 covers three topics, viz., inverters, choppers and cycloconverter. Single- and three-phase voltage and current-driven inverters are covered in detail. However, more elaborate treatment of pulse-width modulation controls from design implementation point of view would have been welcome. Various types of choppers and cycloconverters are covered next. Some worked-out examples would have made the treatment better.

Chapter 10 covers some aspects of dc and ac motor controls. The principles of dc motor control are well illustrated covering various aspects of control, reversibility, etc. Phase and chopper control are well explained. Induction motor speed control by stator voltage variation, variable frequency operation, etc., are covered along with breaking aspects. Synchronous motor control and commutator-less dc motors are mentioned at the end. The utility of this chapter could have been enhanced by giving a case study of dc and ac motor controls, so that, entire system aspects would have been made clearer.

While the book has been brought out well, the usefulness of the book can be enhanced by giving consideration to the following points:

- a) By including more number of worked-out examples for better appreciation of the subject;
- b) By introducing exercises at the end of each chapter, a variety of problems could be conveyed to the reader;
- c) It would have been preferable to use only metric units;
- d) There is a good list of references on the literature. However, their value would have enhanced if they were cited in the text at the appropriate places;
- e) Some of the recent topics like switched-mode converters, resonant converters, etc., should find adequate coverage;
- f) Microprocessor-based control technique could have been covered more exhaustively;

g) A chapter on application of power electronics in areas like battery charging, uninterrupted power supplies, electroplating would have been welcome by the users.

In spite of all the above limitations, the book is well brought out with adequate illustrations of waveforms, etc., and mostly free of printing errors. The author should be complimented for the painstaking efforts in bringing out such a good book on power electronics.

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Research on laser theory edited by A. N. Orayevskiy. Nova Science Publishers, 283, Commack Road, Suite 300, Commack, New York 11725, USA, 1988, pp. 288, \$ 110.

This volume represents volume 171 in the Proceedings of the Lebedev Physics Institute of the USSR Academy of Sciences.

It covers the important subject of the theory of lasing in excimer, CO₂, Nd:YAG, NaCl, He-Ne and other lasers. These lasers have potential for high-energy lasing useful in laser thermonuclear fusion experiments as well as in directed energy weapons and thus a fuller understanding of the theory of such lasers is considered very important. This shows the large amount of fundamental theoretical work which has been done on lasers in the Soviet Union.

In the first paper, Orayevskiy (Dynamical stochasticity and lasers) examines the developmental features and properties of solutions of the Strange Attractor or Lorentz Attractor type, within the scope of an investigation of dynamical conditions in quantum mechanical oscillators. Starting from Maxwell's equations, Poincaré diagrams are given for various cases which can be used to identify many properties of a non-linear system. The investigation of the Strange Attractor as a topological formation indicates that it is a close set of mutually unstable trajectories.

Today the issue of dynamical stochasticity in lasers is the subject of heightened interest.

In the second paper, Basov *et al* (A theoretical analysis of oxygen-iodine chemical lasers) present a theoretical analysis of oxygen-iodine chemical lasers. This study presents results from a theoretical investigation that make it possible to evaluate the physical capabilities of the oxygen-iodine chemical laser as well as to identify promising designs and to optimize their characteristics, for use in applications in laser engineering, laser chemistry, medicine and laser thermonuclear fusion.

In the next paper, Molchanov (The theory of active media in excimer lasers) covers the theory of excimers in condensed rare gases. Based on a group-theoretical analysis and calculations using a model Hamiltonian, a theory of the active medium of a KrF laser excited by a fast electron beam is presented in detail. In order to calculate the influ-

ence of amplified spontaneous emission on the characteristics of wide-aperture optical amplifiers, a method is proposed for numerical solution of an emission transfer equation. This method, which is a natural generalization of the 'forward-reverse' approximation in transport theory makes it possible to calculate a 3-D field of amplified spontaneous emission in optical resonators accounting for diffusive reflection off lateral walls. In conclusion, a self-consistent solution of a system of kinetic and field equations is used to calculate the characteristics of wide-aperture KrF amplifiers (KrF is useful in laser thermonuclear fusion).

Biryukov and Shcheglov (Lasers operating at the cascade transitions of linear triatomic molecules) conduct a theoretical investigation of cascade lasing from linear triatomic molecules (CO_2 , N_2O , CS_2). The general conditions required for operation of such lasers in an intermittent pulsed mode are formulated. Their features are discussed as a function of the excitation method (electric discharge, thermal and chemical pumping). The energy parameters of cascade gas lasers are evaluated and specific practical recommendations are given with regard to the development of such systems including the selection of optimum cavity lengths (in the flow direction), mixture composition, and Q-switching pulse repetition rate. The possibility of implementing a gas flow molecular laser emitting simultaneously at three wavelengths is discussed.

Pestov (The theory of ring quantum-mechanical oscillators in a magnetic field of arbitrary direction) develops a theory which can be used as an analytical basis for investigating the possibility of developing and building an independent quantum instrument to measure the magnitude and direction of an external magnetic field: a quantum magnetometer as well as to develop methods of improving the accuracy of other measurement instrumentation that employ ring quantum-mechanical oscillators. A theory of ring quantum-mechanical oscillators in single mode lasing is used to determine the amplitude and frequency responses of the ring quantum-mechanical oscillators in a mechanical field of arbitrary direction and are then used as the basis for investigating the nonlinear 'polarization' nonreciprocal effects with arbitrary wave polarization vectors in longitudinal and transverse magnetic nonreciprocal effects are investigated in a magnetic field of arbitrary direction. The 'polarization' effect of damping of competition of counter-running waves in a magnetic field is examined. Also examined is the 'parametric' beat frequency locking effect in ring quantum-mechanical oscillators with both harmonic and quasi-periodic variation in the external magnetic field. The developed theory is compared to particular variants of ring quantum-mechanical oscillator theory and experimental data. A formula is derived for the beat frequency as a function of the various parameters of the ring quantum-mechanical oscillator which makes it possible to formulate an algorithm for a precise determination of the beat frequency shift caused by the measured factors influencing the characteristics of the ring quantum-mechanical oscillator (such as the speed of rotation of a ring resonator in laser gyroscopes) which are used in aircraft, rockets and spacecraft.

There are some errors in translation, e.g. on p. 266 'the locking band is determined not only the amplitude of the variable component' when it should have been 'determined by only'.

Overall, it can be stated that the book provides a detailed account of the theory of lasing action in some active media, and is recommended for reading by researchers in this field. Studies of rare conditions in several laser media have been compiled in this book. It will surely give good guidelines for theoretical investigations on lasing action.

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Handbook on refractories by D. N. Nandi. Tata McGraw-Hill Publishing Company Limited, 4/12, Asaf Ali Road, New Delhi 110 002, 1987, pp. 236, Rs. 120.

Handbook on refractories is really not a handbook in the normal sense, as it deals with fundamental aspects of the properties, manufacturing processes, quality control and applications in addition to technical data on a variety of commonly used refractories. The author, with his vast experience in the field of refractories, has treated the reader with all possible information on refractory materials.

The introduction chapter classifies the refractories based on their chemical nature and is followed by a set of phase diagrams which virtually covers all the useful refractory systems. This is preceded by the descriptive discussions on the raw materials, their occurrence, availability and production. The statistical figures on annual world production and India's share are noteworthy and valuable.

The process of manufacturing refractories from the raw materials is subsequently covered very briefly. The flow sheets given are self-explanatory. Inclusion of the production of special refractories, unshaped refractories and insulating refractory bricks needs special mention. Quality control, which is an essential part of any manufacturing activity, is very briefly described under the headings of raw materials and finished products. Inspection and testing procedures for quality assessment are given adequate coverage. The basic procedures for assessing chemical composition, refractoriness, linear change on heating, crushing strength, spalling resistance, thermal expansion, conductivity, abrasion resistance, corrosion resistance, hot torsional strength, hot crushing strength and thermal analysis are narrated so that even a novice can understand and practise these acceptance tests. The brief mention about the X- and R-bar charts aptly concludes the discussion on quality assurance.

Standard specifications, which are the guidelines for meeting quality standards are very briefly covered, and the titles of the relevant international specifications listed. However, in a handbook, one would have expected to have the detailed specifications of at least the most important property requirements rather than just the titles.

Data on the consumption norms of refractories by major industries and on the production of refractory consuming industries in India seem to be out of place, and being totally outdated, do not seem to be of much use. However, the subsequent details on the types of refractories suggested for different furnaces used in iron and steel, aluminium, and

copper industries and in glass-melting furnaces are very informative and apt. Particular reference must be made of the excellent coverage of the reactions of various materials with refractories.

The chapter on application techniques fails to justify the importance of the factors to be considered. The discussion in this chapter seems to be in separate bits, unconnected with each other and with the otherwise continuously running matter.

Glossary of terms is fairly elaborate and the definitions are, by and large, quite crisp. Part of the technical data given in the last chapter is bound to be handy to the practising engineers and technicians. However, in such a volume covering a specialized topic of refractories, the pages giving conversion from °Celsius to °Fahrenheit and the temperature vs millivolts relationship for different thermocouple wires seem to be totally elementary.

A special word of appreciation to the list of references cited at the end of each chapter. The book is prepared with utmost care and the get-up is excellent. It should prove to be a valuable addition to the libraries in engineering colleges and to the collection in metallurgical and related industries.

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