

Technical Papers by IBM Authors Published Recently in Other Journals

Adaptive Data Compression, C. A. Andrews, J. M. Davies and G. R. Schwarz, *Proceedings of the IEEE* **55**, No. 3, 267-277 (March, 1967).

Data compression techniques are classified into four categories which describe the effect a compression method has on the form of the signal transmitted. Each category is defined and examples of techniques in each category are given.

Compression methods that have received previous investigation, such as the geometric aperture methods, as well as techniques that have not received much attention, such as Fourier filter, optimum discrete filter, and variable sampling rate compression are described. Results of computer simulations with real data are presented for each method in terms of rms and peak errors versus compression ratio.

It is shown that in general the geometric aperture techniques give results comparable to or better than the more "exotic" methods and are more economical to implement at the present state of the art. In addition, the aperture compression methods provide bounded peak error which is not obtainable with other methods.

A general system design is given for a stored-logic data compression system with adaptive buffer control to prevent loss of data and to provide efficient transmission of multiplexed channels with compressed data. An adaptive buffer design is described which is shown to be practical based on computer simulations with five different types of representative data.

The Algebraic-Topological Basis for Network Analogies and the Vector Calculus, F. H. Branin, Jr., *Proceedings of the Symposium on Generalized Networks*, Microwave Research Institute Symposia Series **16**, pp. 453-491 (April, 1966).

Network analogies exist for a variety of physical systems including many described by the vector calculus. An explanation of this fact is given in terms of the algebraic-topological principles upon which both network theory and the vector calculus are based. The usual network problem is shown to consist of both a topological structure, called a linear graph, and an algebraic structure whose properties, once identified, lead directly to firm ground rules for setting up network analogies. Electrical, mechanical, and structural networks are discussed as examples. By extending the algebraic-topological treatment of linear graphs to topological structures containing surface and volume elements, a direct linkup between network theory and the vector calculus becomes possible. Two significant results of this development are: (1) a novel topological interpretation of Maxwell's equations for the electromagnetic field, and (2) the validation of network representations for two large classes of partial differential equations.

An Algorithm for Generating Permutations, G. G. Langdon, Jr., *Communications of the ACM* **10**, No. 5, 298-299 (May, 1967).

An algorithm is described which under repeated application generates all permutations of K elements. Only the previously generated permutation, the constant K , and a temporary index are

needed. Starting with a particular ordering of K elements ($abcd$), repeated application of the algorithm will generate $K - 1$ additional permutations by $K - 1$ successive rotations. From the initial circular ordering of K objects, another circular ordering can be obtained by rotating the $K - 1$ lowest elements. For each new $K - 1$ circular ordering, another $K - 2$ can be obtained by rotating the $K - 2$ lowest elements. By continuing in this manner, applications of the algorithm will generate all $(K - 1)!$ circular orderings, or since each circular ordering yields K permutations the algorithm generates all $K!$ permutations.

The Apparent Ionic Charges and Vibrational Eigenmodes of BaTiO₃ and Other Perovskites,* J. D. Axe, *Physical Review* **157**, No. 2, 435-437 (May 10, 1967).

The polarization associated with the vibrations of a complex lattice can be discussed by assigning apparent charges to the individual ions. These apparent charges can be calculated for a lattice of electrically polarizable ions by a consideration of the local dipole fields if polarization due to short range forces is neglected, and such calculations are made for several cubic perovskites. Using these calculations as criteria for reasonable values of apparent charges results in the severe restriction of the range of the displacements permissible for the polar vibrational modes compatible with the experimentally observed mode dipole strengths. The apparent ionic charges and polar eigenmodes of SrTiO₃, BaTiO₃, KTaO₃ and KCoF₃ are discussed in this manner. For BaTiO₃ the magnitude of the spontaneous polarization is correctly predicted, and the displacements predicted for the very low frequency mode in the cubic phase are closely similar to those which occur at the cubic tetragonal phase transformation.

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An Application-Oriented Multiprocessing System, Part I, Introduction, *IBM Systems Journal* **6**, No. 2, 78-79 (1967).

The purpose of this short introduction is to provide background for a discussion of an application-oriented multiprocessing system.

An Application-Oriented Multiprocessing System, Part II. Design Characteristics of the 9020 System, G. R. Blakeney, L. F. Cudney, and C. R. Eickhorn, *IBM Systems Journal* **6**, No. 2, 80-94 (1967).

The equipment that comprises the IBM 9020 multiprocessing system is described, emphasizing capabilities not appearing in the standard System/360 line. System characteristics are related to availability requirements for program-controlled reconfiguration capabilities. With these capabilities, subsystems can be formed from system elements as the need arises. Other discussed functional capabilities center on recovery by program control, shared storage, and malfunction alerting.

An Application-Oriented Multiprocessing System, Part III. Control Program Features, J. A. Devereaux, *IBM Systems Journal* 6, No. 2, 95-102 (1967).

The described control program dynamically schedules the operational activities performed by the IBM 9020 multiprocessing system. Scheduling is based on program execution requirements and allows dynamic switching of Computing Element assignments. Storage resources are dynamically allocated by the control program to guard against the mutual interference of concurrent operations. The trace capability of the control program is described because of its importance to the checkout and evaluation of multiprocessor systems.

An Application-Oriented Multiprocessing System, Part IV. The Operational Error Analysis Program, D. C. Lancto and R. L. Rockefeller, *IBM Systems Journal* 6, No. 2, 103-115 (1967).

The described program analyzes and isolates equipment faults concurrently with regular processing. If necessary, the program replaces system elements by realigning communication and control paths. Dependence of the program's replacement decisions upon the recording of extensive error statistics is also discussed.

An Application-Oriented Multiprocessing System, Part V. The Diagnostic Monitor, R. Suda, *IBM Systems Journal* 6, No. 2, 116-123 (1967).

Off-line diagnostic programs for system test, acceptance test, and field maintenance of the IBM 9020 multiprocessing system are executed under control of the monitor under discussion. The structure of the monitor is based on seven functional components which are examined in detail. A discussion of the debugging experience during the development of the monitor is included.

An Application-Oriented Multiprocessing System, Part VI. Programs for the Intended Application, F. K. Seward, *IBM Systems Journal* 6, No. 2, 124-132 (1967).

The multiprocessing system is viewed within the frame of the intended air-traffic-control application. Functions of the five application-oriented programs, as well as the main features of the input/output environment, are discussed.

Approximations and Bounds for Eigenvalues of Elliptic Operators, L. Fox,* P. Henrici,** and C. Moler*** *SIAM Journal on Numerical Analysis* 4, No. 1, 89-102 (1967).

A method is presented to obtain rigorous bounds for the eigenvalues of certain self-adjoint elliptic partial differential operators. The main tools are the Krylov-Bogoliubov inequality, the maximum principle, and the Bergman-Vekua theory of complete systems of solutions. The method is applied to estimate the lowest ten fundamental frequencies of an L-shaped membrane. The results are far superior to those obtained by other means.

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Automatic Information System, R. Dubon, *L'Onde Electrique* 47, No. 482, 663-668 (May, 1967).

The IBM's European Technical Information Center offers a centralized and computerized in-house information Retrieval and Dissemination System for IBM's scientific and technological personnel in Europe. The system uses an IBM 1401 for input/output and an IBM 7090 for searching approximately 120,000 words/minute. The answers are printouts of the text which satisfy the question logic. The technique used at La Gaudie for retrospective searching and for a Current Information Selection system is a Normal Text Information Retrieval System. With each abstract the individual user receives a Port-a-Punch response card, the user returns the response card to his local European Technical library for processing.

Automation in Libraries: A Projection, M. Griffin, *Canadian Library* 23, No. 5, 360-367 (March, 1967).

The need for libraries to adapt themselves to the evolving technology of automatic processing and handling of information is discussed.

Bias Sputtering of Molybdenum Films, R. Glang, P. C. Furois and R. A. Holmwood, *Advances in Vacuum Science and Technology: Transactions of the Third International Vacuum Congress* 2, (Parts 1-3) pp. 643-650 (1966).

Cathodic sputtering of molybdenum in argon of 40-70 μ pressure at 2 to 4 kV has been investigated. Films about 1 μ thick were deposited on oxidized silicon crystal wafers. During deposition, the substrate wafers were kept at various negative potentials up to 150V, and their temperature was controlled within $\pm 5^\circ\text{C}$. The negative bias in conjunction with the close spacing between cathode and substrate holder produced a discharge behavior, similar to a hollow cathode, i.e. increased light emission and cathode current. The latter is reflected in deposition rates of 20 $\text{\AA}/\text{sec}$ at -150V bias compared to 5 $\text{\AA}/\text{sec}$ without bias. The effects of gas pressure, cathode voltage and cathode to substrate distance on deposition rates have also been determined.

The properties of sputtered molybdenum films depend primarily on the deposition temperature and the bias voltage. Resistivities of 10-12 $\mu\Omega/\text{cm}$ can be obtained at 300-600 $^\circ\text{C}$ with bias voltages exceeding -50V. At 100 $^\circ$ to 200 $^\circ\text{C}$ and without bias, resistivities are 200-250 $\mu\Omega/\text{cm}$. Negative bias alone produces compressive film stress, while increased deposition temperatures contribute tensile stress. Film adhesion to SiO_2 surfaces is generally good except for some high bias-high temperature combinations. The films are polycrystalline and show preferred grain orientation. Low temperatures without bias favor (110), large negative bias voltages (211), high temperature (111) orientation. The combination of both variables produces mixed to random orientations. The results are compared with properties of molybdenum films evaporated in high vacuum.

Budgeting for a Company Library, G. E. Randall, *Special Libraries* 58, No. 3, 166-172 (March, 1967).

Meaningful budgets (that is, the statements of estimated revenues and expenditures) will vary from library to library. Basic patterns, however, remain the same. The largest element in a library budget is expenditures for personnel, the second largest for literature. This paper discusses methods of arriving at average and practical figures for professional and other library staff salaries and for literature costs, and arrives at a basic budget for a hypothetical library.

Calculation of Zero-Field Splitting in NH. II. One-Center Representations of Triplet States, John B. Lounsbury, *Journal of Chemical Physics* **46**, No. 6, 2193-2200 (March 15, 1967).

The zero-field-splitting (ZFS) parameters arising from electron spin-spin dipolar interactions in the known triplet states of NH are calculated. A variety of one-center expansion (OCE) representations are utilized, including an extended basis wavefunction for the ground state. Overlaps of limited basis OCE eigenvectors with extended basis OCE eigenvectors and with two-center eigenvectors are calculated for $^3\Sigma - \text{NH}$. In addition, electron-density distributions are calculated for the various $^3\Sigma - \text{NH}$ representations. It is concluded that, at least for $^3\Sigma - \text{NH}$, OCE representations in general and limited basis OCE representations in particular describe the distributions of the innermost and outermost electron shells relatively better than distributions of the remaining electrons. Electron spin-spin dipolar interaction in $^3\Sigma - \text{NH}$ is found to be much larger than for $^3\Pi_0\text{NH}$; $D = 1.5951 \text{ cm}^{-1}$ for $^3\Sigma - \text{NH}$ using a 24 basis representation and $D = 0.512 \text{ cm}^{-1}$ for $^3\Pi_0\text{NH}$ using a 12 basis representation. The electronic configurations of organic nitrenes are discussed qualitatively. Directions of future ZFS calculations for nitrenes are suggested.

The Case for an In-House Glass Technology, B. Sunners, *Insulation* **13**, No. 4, 50-55 (April, 1965).

This paper describes the advantages of an in-house glassing technology in the semiconductor industry. Such a capability may be necessary to formulate glasses for the special needs of semiconductor as well as to aid in the selection of commercial glasses.

Coating Normalizes IR Emissivity, G. W. Carter, *Electro-Technology* **79**, No. 4, 89-90 (April, 1967).

A conformal coating allows the use of infrared techniques to locate shorts, undetectable by other means, within multilayer circuit boards.

Comments on the Supercooling Field for Superconductors with κ Values near 0.4, J. Feder, *Solid State Communications* **5**, No. 4, 299-301 (April, 1967).

The possibility of having a superconducting surface sheet in a supercooled type I material is discussed in terms of the Ginzburg-Landau theory.

Communication-System Blackout During Reentry of Large Vehicles, F. H. Mitchell, Jr., *Proceedings of the IEEE* **55**, No. 5, 619-626 (May, 1967).

Much of the theoretical research on reentry blackout is in a format difficult for the communications design engineer to use in his system analysis. This paper derives simplified equations for the average sheath power loss that may be added (in dB) to the usual space loss to obtain an approximate total propagation loss. From these calculations, the duration of the communications blackout may be found.

The plasma and sheath properties are discussed in detail but largely without supporting mathematics, in order to give the design engineer a better understanding of the overall problem. For the same reason and to provide insight into the final results, the average radiated power is found, using both intuitive and rigorous techniques. Several graphs of plasma properties are included in the development as an aid to numerical computations, and results are compared with the work of other authors.

Computer-Assisted Circuit Engineering, J. A. Zumbado and J. B. Eggerling, *Proceedings of the NASA Electronics Research Center Computer-Aided Circuit Design Seminar*, pp. 65-74 (1967).

This paper describes the capabilities an engineering organization must consider to perform circuit design and analysis efficiently with the aid of computers. The availability of a large computer system is assumed. Circuit engineering considers the worst-case circuit performance, which is a function of piece-part tolerances, temperature environment, and aging. Circuit performance criteria include dc stability, power dissipation, and dynamic performance. Dynamic performance encompasses transient behavior, dynamic stability, and four-terminal network characterization of module circuitry. While emphasis is given to circuit analysis and design, system design and analysis can be, and has been, performed using the basic approaches described herein. Accurate and timely circuit engineering is based upon: (a) accurate circuit parameter characterization, (b) flexible network analysis computer programs, (c) continuous computer program development, and (d) empirical investigations in adequate laboratories.

Computer Partitioning Improves Long-Term Reliability in Space, M. Ball and F. H. Hardie, *Space Aeronautics* **47**, No. 5, 114-118 (May, 1967).

The ground rules and trade-offs used to electrically partition an extended-mission space computer are discussed. The configured computer used triple modular redundancy and electrical partitioning to meet computer reliability goals.

A Continued Fraction Algorithm for the Computation of Higher Transcendental Functions in the Complex Plane, I. Garganti and P. Henrici,* *Mathematics of Computation* **21**, No. 97, 18-29 (January, 1967).

This report deals with the numerical evaluation of a class of functions of a complex variable that can be represented as Stieltjes transforms of non-negative real functions. The considered class of functions contains, among others, the confluent hypergeometric functions of Whittaker and the Bessel functions. The method makes it possible, in principle, to compute the values of the function with an arbitrarily small error, using one and the same algorithm in whole complex plane cut along the negative real axis. Detailed numerical data are given for the application of the algorithm to the modified Bessel function $K_0(z)$.

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Control of Photoconductive Properties in Cadmium Selenide, B. Sunners, *Journal of the Electrochemical Society* **114**, No. 4, 390-394 (April, 1967).

Some aspects of the chemistry of sintered cadmium selenide photoconductors are presented. A tentative scheme is outlined whereby electrical requirements for such photoconductive devices can be used to define the chemistry of the sintered layer. Experimental methods are outlined, and the effects of some process variables on the electrical properties are described. The application of the method is described.

Current and Future Trends in Programming Languages, J. E. Sammet, *Computers and Automation* **16**, No. 3, 32-34 (March, 1967).

The paper contains a very brief discussion of the following languages: FORTRAN, ALGOL 60, COBOL, IPL-V and LISP, COMIT and SNOBOL, FORMAC, JOVIAL, PL/I, Simulation Languages. It then lists four current developments which are likely to have a long-range effect on programming languages.

Damping System Eliminates Vibrations in Sensitive Equipment, R. P. Esch and R. A. Leonard, *Laboratory Management* **5**, No. 5, 16-17 (May, 1967).

Combination of a floating disc, resembling the Hovercraft principle, and tennis balls minimizes vibration problems concerned with a photographic measuring technique.

Data Collection System Controls Manufacturing, J. E. Kunze, *Tool and Manufacturing Engineer* **58**, No. 4, 134-137 (April, 1967).

A computerized system based on IBM 357 off-line terminals permits rigid control of manufacturing operations, yet allows the introduction of both part handling and scheduling changes. This technique is called real-time dispatching. In use in the plant's machining area at IBM Rochester, the system provides dynamic control of parts manufacturing and subassembly operations.

Digital Analysis of Bursts in the Time Domain, W. W. Lang, G. C. Maling, Jr. and W. A. Taylor, Jr.,* *IEEE Transactions on Audio and Electroacoustics* **AU-15**, No. 1, 15-19 (March, 1967).

A technique is described for analyzing bursts and burst-like events with a digital recording system and a general-purpose computer. The waveform of the burst is sampled by an analog-to-digital converter and stored on magnetic tape. The digitized samples are used as input data to an IBM 7094 data processing system for which a burst-analysis program has been written in the FORTRAN language. The analysis of amplitude and shape variations of a burst train is completed without manual processing of the data. This technique is used to analyze the acoustical noise produced by a card punch.

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Direct Measurement of the Electron Velocity and Mean Free Path in Gallium, R. J. Gutfeld and A. H. Nethercot, Jr., *Physical Review Letters* **18**, No. 20, 855-857 (May 15, 1967).

The Fermi velocity has been measured by a heat-pulse time-of-flight technique near the a axis in gallium. Also, the electron mean free path has been measured in several gallium samples between ~ 1.8 and 4.0°K .

Divergence in the Kalman Filter, F. H. Schlee, C. J. Standish and N. F. Toda, *AIAA Journal* **5**, No. 6, 1114-1120 (June, 1967).

Under certain conditions, the orbit estimated by a Kalman filter has errors which are much greater than predicted by theory.

This phenomenon is called divergence and renders the operation of the Kalman filter unsatisfactory. This paper investigates the control of divergence in a Kalman filter used for autonomous navigation in a low earth orbit. The system studied utilizes stellar-referenced angle sightings to a sequence of known terrestrial landmarks. A Kalman filter is used to compute differential corrections to spacecraft position, spacecraft velocity, and landmark location. A variety of filter modifications for the control of divergence were investigated. These included the Schmidt-Pines analytical modification and an "empirical" modification based upon Pines' machine noise treatment. Several simplified approximations to the theoretically optimum analytical modifications were also investigated. The principle numerical results are presented in graphs of the magnitude of the error in estimated position and velocity versus time for sixteen orbits. These graphs compare actual position and velocity errors with the theoretical estimates furnished by the trace of the position and velocity covariance matrices. Numerical results indicate that a properly modified filter achieves a steady-state operating level.

Effective Charge of Ti^{4+} Estimated from the Paramagnetic Resonance of Mn^{4+} in SrTiO_3 , K. A. Müller, *Proceedings of the International Meeting on Ferroelectricity, Prague*, Vol. II, pp. 369-372 (1966).

The charge reduction due to σ and π bonding of the $3d$ levels, of Mn^{4+} , which should be close to those of Ti^{4+} , has been estimated from EPR data to be $q_{3d} = (1.96 \pm 0.12)e$. Including a cruder estimate of the charge reduction due to σ bonding resulting from $4s$ and $4p$ levels of $q_{4s,4p} > 1.8e$, one arrives at an effective charge of the Ti in ATiO_3 , $q_{\text{eff}} = 4 - q_{3d} - q_{4s,4p}$, close to zero.

Electron Gun Using Long Life Lanthanum Hexaboride Cathode, A. N. Broers, *Journal of Applied Physics* **38**, No. 4, 1991-1992 (March 14, 1967).

An electron gun is described for use with demountable electron beam instruments where the vacuum is obtained using oil diffusion pumps and elastomer o-rings. The gun uses a lanthanum hexaboride rod cathode with two orders of magnitude greater lifetime than the conventional tungsten hairpin at any given brightness. The electron gun has been used to produce stably an electron beam with a brightness of 5×10^4 amp/cm²/steradians at 12kV for periods in excess of 1000 hours.

Epitaxial Deposition of GaAs in an Argon Atmosphere, R. C. Taylor, *Journal of the Electrochemical Society* **114**, No. 4, 410-412 (April, 1967).

Of the several methods currently available for epitaxial deposition of GaAs, the open tube method using Ga and AsCl_3 in a hydrogen atmosphere has given material with the best electrical properties to date for applications such as Gunn effect devices. In the present investigation, argon was substituted for hydrogen as the carrier gas. There are several potential advantages suggesting the use of argon for the purpose of obtaining better and more reproducible films. Among these are: substitution of an inert species for a reactive one to eliminate at least one reaction from the system, substitution of a heavier carrier gas to minimize the density differential between the carrier and the reacting species and decrease any compositional gradient existing in the gas phase, and elimination of the hydrogen reduction of quartz as a source of silicon contamination to give a purer GaAs deposit.

Equilibrium States of Elastic Rings, I. Tadjbakhsh and F. Odeh, *Journal of Mathematical Analysis and Applications* **18**, No. 1, 59-74 (April, 1967).

An Experimental Word Decode and Drive System for a Magnetic Film Memory with 20-ns Read-Cycle Time, D. Seitzer, *IEEE Transactions on Electronic Computers* **EC-16**, No. 2, 172-179 (April, 1967).

Design principles of a word selection and drive scheme for a 20-nsec nondestructive-read-cycle-time flat-film memory with 150,000 bits storage capacity, are presented and verified by cross-sectional tests. The word lines are matched at one end and driven from the other by a high-speed driver building block compatible with integrated circuit technology which is connected to a decode matrix. Suitable decode matrix line drivers for providing pulses of different width and amplitude for read operations up to 50 MHz and write operations up to 20 MHz, respectively, are described. Experiments with a cross-sectional setup for 64 outputs prove the feasibility of the system. Its operation in connection with a memory model indicates an access time of 30 nsec.

Experiments on the Separation of a Fluid Jet From a Curved Surface, D. W. McGlaughlin and I. Greber, *Advances in Fluidics* (Proceedings of Fourth Annual ASME Fluidics Symposium), p. 14 (1967).

Results are reported of experiments examining the mechanism of separation of a fluid jet from a curved wall. Conditions under which laminar separation, turbulent separation, and enclosed separated regions occur are discussed. The existence of hysteresis in the variation of separation angle with Reynolds number, and the existence of regions of unstable oscillations are pointed out. Some effects of wall heating on the separation phenomena are indicated.

Frequency Demultiplexing Using Computer Techniques, A. Piscopo, *Telemetry Journal* **2**, No. 3, 42-48 (April-May, 1967).

The demultiplexing of an FM/FM signal is demonstrated through the use of correlation techniques. Equivalent computer functions are derived for both the bandpass filter and FM discriminator used in an Inter-Range Instrumentation Group (IRIG) telemetry ground station. Emphasis is on functional concepts and the use of a general purpose computer, IBM System/360. Results are presented in the form of computer plots. Full implementation of these concepts would require further study in both the engineering and programming areas.

Frequency Response of "PIN" Avalanche Photodiodes, J. J. Chang, *IEEE Transactions on Electron Devices* **ED-14**, No. 3, 139-145 (March, 1967).

The frequency response of a PIN avalanche photo-diode has been analyzed without the usual assumption that the electrons and the holes have equal ionization rates ($\alpha_n = \alpha_p$) and equal scattering-limited velocities ($v_n = v_p$). A general formula for the frequency response is first derived for the case in which the photons are absorbed in the space charge region or i region and the photon density decreases with penetration depth according to $e^{-\alpha x}$. The frequency response for the case of photon absorption in the p or n region is obtained simply by letting α approach infinity in the general formula and that for the case of uniform absorption of photons in the space charge region by allowing α to approach zero.

The analysis, based on a model in which the photons come from the p side, shows the following:

1) The dc multiplication factor does not depend on v_n and v_p in any manner. It does not depend on α if $\alpha_n = \alpha_p$. When $\alpha_n > \alpha_p$, the dc multiplication factor increases with increasing α according to

$$M_A(0)/M_B(0) = [1 - \exp(-\alpha w - \alpha_n w + \alpha_p w)] / [1 + (\alpha_n - \alpha_p)/\alpha] \cdot [1 - \exp(-\alpha w)],$$

where $M_A(0)$ and $M_B(0)$ are the dc multiplication factors for finite and infinite α , respectively, and w is the space charge region width. $M_B(0)$ is given by $(1 - \alpha_n w)^{-1}$ when $\alpha_n = \alpha_p$ and by $[\exp(-\alpha_n w) - \alpha_p/\alpha_n]^{-1}$ when $\alpha_n \gg \alpha_p$.

2) The cutoff frequency f_{co} does not in any case depend on α but depends on α_n and α_p and on an "effective scattering-limited velocity" v_e , defined as $v_n v_p / (v_n + v_p)$. For $\alpha_n = \alpha_p$, the cutoff frequency is given by $f_{co} \simeq 3v_e / [\pi w M_B(0)] \simeq 3\alpha_n v_e / [\pi M_B(0)]$. For $\alpha_n \gg \alpha_p$, f_{co} is greatly improved and is given by $f_{co} \simeq \alpha_n v_e / [2\pi w \alpha_p M_B(0)]$.

Fundamental Concepts of Programming Languages, J. E. Sammet, *Computers and Automation* **16**, No. 2, 30-35 (February, 1967).

This paper provides defining characteristics of a programming language rather than an explicit definition. It then discusses the advantages and disadvantages of programming languages. Various classifications and proposed definitions for them are given. Non-technical and technical characteristics of programming languages are listed and described.

Galliumarsenid- und Silizium-MS-Transistoren, H. Statz, *Verhandlungen der Deutschen Physikalischen Gesellschaft* **2**, No. 1, 60 (1967).

A Graphic-Output Adapter for Remote Plotting, E. T. Johnson, *Eighth National Symposium of the Society for Information Display*, pp. 265-271 (May 24, 1967).

An experimental graphic-output adapter has been developed for use with the IBM 1051 and 2741 typewriter terminals which receive and send information over voice-grade telephone lines. The adapter can drive a digital plotter, an analog plotter, or a storage CRT, asynchronously. It can draw both points and X, Y, 45° vectors; furthermore, it offers a flexible, potentially low-cost alternative to on-line display systems.

The Gunn Effect, O. G. Folberth, *Zeitschrift für angewandte Physik* **22**, No. 6, 553-562 (1967).

The basic experiment of the Gunn Effect is in principle very simple: An electrical field of more than 3000 V/cm is generated within a homogeneous specimen of a suitable semiconductor (e.g., n -type GaAs with a specific resistivity of about 10Ω cm). Under these conditions current oscillations appear with a frequency proportional to the mean drift velocity of the conduction electrons and reciprocal to the (effective) length of the specimen. For short specimens (<0.1 mm) the frequency is greater than 1 GHz.

The technical importance of the Gunn Effect derives from the possibility of influencing the drifting and quenching of the domains by variation of the circuitry and the working condition to produce different oscillation-modes. Such devices can be used for generation and amplification of microwaves at power and voltage levels inaccessible to other solid-state devices. Technological problems, such as material and contact inhomogeneities, however, still deserve intensive development effort.

How Long is the Coast of Britain? Statistical Self-Similarity and Fractional Dimension, B. Mandelbrot, *Science* **156**, No. 3775, 636-638 (May 5, 1967).

Geographical curves are so involved in their detail that their lengths are often infinite or, rather, undefinable. However, many are statistically "self-similar," meaning that each portion can be considered a reduced-scale image of the whole. In that case, the degree of complication can be described by a quantity D that has many properties of a "dimension," though it is fractional; that is, it exceeds the value unity associated with the ordinary, rectifiable curves.

Hybrid Technique Applied to a Binary Full Adder, F. Hilsenrath, *Electronic Design* **15**, No. 10, 98 (May 10, 1967).

A binary full adder, requiring only six transistors, can be designed to function with a single level of logic or stage of delay from input to either the sum or carry outputs. The desired logic functions are implemented by means of an OR circuit, an AND circuit, and one majority logic block, arranged in parallel. Design of the three blocks is accomplished easily with level sensitive current feedback switches. Binary full adders typically require additional transistors and several stages of delay, after proper circuit minimization, to perform the sum and carry operations.

IBM Mobile Room Lends Flexibility to Apollo Saturn Unit Fabrication, H. Heuring, *Contamination Control* **6**, No. 4, 30-32 (April, 1967).

This paper covers the methods and equipment used by the IBM Federal Systems Division at Huntsville, Alabama, to achieve and maintain extreme cleanliness during the assembly and check-out of the environmental and guidance systems on the Saturn Instrument Unit. It specifically describes the special portable clean room that provides a clean area wherever it is needed. This includes the design and operation of the clean room, the levels of cleanliness, and the environmental requirements. Also covered are quality control requirements, maintenance of the portable clean room and a description of the working conditions. The paper concludes with a discussion of the special personnel required for this work, and the service record of the facility.

Image Quality and Target Recognition, C. A. Bennett, R. E. Kent and S. H. Winterstein, *Human Factors* **9**, No. 1, 5-32 (February, 1967).

The terminology and literature in the area of image quality and target recognition are reviewed. An experiment in which subjects recognized strategic and tactical targets in aerial photographs with controlled image degradations is described. Some findings are: Recognition performance is only moderate for representative conditions. There are wide differences among target types in the recognizability. Knowledge of a target's presence (briefing) greatly aids recognition. Better resolution means better performance. Enlarging the image such that a line of resolution subtends more than three minutes of arc hinders recognition. Grain size should be kept below 20 seconds of arc. It is suggested that the eventual application of the modulation transfer function approach to measurement of image quality and target characteristics will enable a quantitative subsuming of various quality-size relationships. More attention needs to be paid in recognition research to suitable task definition, target description, and subject selection.

An Improved Environmental Chamber Alarm System, R. J. Janasak and S. L. Casey, *Proceedings of the Institute of Environmental Sciences Annual Symposium* Vol. I, pp. 161-164 (1967).

To avoid the consequences of an environmental chamber malfunction, a monitoring alarm system was designed to provide a warning if the environmental chamber condition should exceed the desired limits of testing. Environmental parameters monitored by the system include wet and dry bulb temperatures, relative humidity, and ambient dew point. The system also removes all chamber power if the malfunction is not corrected within a pre-set time period, and it controls the chamber ambient dew point temperature while chamber conditions are being modified. This report describes the alarm system, its instrumentation and function.

Infrared Dielectric Dispersion of Several Fluoride Perovskites, J. D. Axe,* and G. D. Pettit, *Physical Review* **157**, No. 2, 435-437 (May 10, 1967).

Measurements at room temperature of the infrared reflectivity, low frequency dielectric constant (ϵ_0), and optical index of refraction (n) have been made on KCoF_3 , KMnF_3 , and RbMnF_3 . The reflectivity data have been analyzed using Kramers-Kronig relations to obtain the dielectric dispersion from 50 cm^{-1} to 4000 cm^{-1} . The frequencies of the three t.o. (l.o.) long wavelength polar eigenmodes are 139 (168), 225 (293), 417 (500) cm^{-1} for KCoF_3 ; 115 (143), 193 (268), 395 (479) cm^{-1} for KMnF_3 and 113 (124), 197 (273), 369 (452) cm^{-1} for RbMnF_3 . $\epsilon_0 = 7.35$, 8.28, 7.6 and $n = 1.47$, 1.44, 1.53 for KCoF_3 , KMnF_3 and RbMnF_3 respectively. Mode strengths and damping were also measured. Low temperature reflectivity measurements on antiferromagnetically ordered KCoF_3 were also performed.

* Partially supported by Army Research Office, Durham, N. C., under Contract DA-31-124-ARO-D-205.

In-Process Control of Structural Defects in Semiconductor Manufacturing, G. H. Schwuttke, *Proceedings of the International Symposium on Test Methods and Measurements of Semiconductor Devices*, Paper No. 501, pp. 1-8 (1967)

Crystallographic defects cannot be avoided in manufacturing semiconductor devices. Even if dislocation-free starting material is used, there will be dislocations and other defects introduced through the solid-state diffusion steps that are necessary to form layers of different conductivity. The scanning oscillator technique (SOT) and its application to in-process control of structural defects in semiconductor devices is described. It is shown that SOT micrographs determine not only the physical topographs of entire crystal slices containing devices but also that they distinguish between areas of different crystal perfection. Consequently, they represent imperfection maps of the entire crystal surface. Such imperfection maps can be obtained before and after each processing step, making it possible to determine where and when imperfections were generated in the device. Topographs recorded of the virgin substrate and of substrates after epitaxial deposition, after oxidation, after the opening of windows in the oxide, and after the diffusion processes are discussed. Imperfections introduced by the processing steps are analyzed. Finally, the influence of these defects on device performance is discussed.

Interconnection Analysis for High-Performance Computers Through a Linearized Physical Model, I. T. Ho, 1967 *SWIEECO RECORD of Technical Program Papers, 19th Annual Southwestern IEEE Conference and Exhibition*, pp. 21-2-1 to 21-2-8 (1967).

A novel physical model, with a delay line in parallel to an RC network, can represent a current switch emitter follower and may be used in an analog simulator for high performance computer interconnection analysis.

Junction Delineation by Anodic Oxidation in InSb (As, P), L. L. Chang, *Solid State Electronics* **10**, No. 6, 539-544 (June, 1967).

The rate of anodic oxidation of InSb in KOH has been found to depend on the doping concentration of the semiconductor. The anodization process thus provides a means to delineate junctions in this material and, similarly, in InAs and InP. Anodization patterns have been correlated with the profiles of diffusion by which the junctions are fabricated. Zn- and Cd-diffused junctions in InSb have been studied in some detail; the latter are consistently flatter and have better electrical characteristics. The cause seems to lie in the semiconductor, involving a residual impurity reacting with the diffusing Zn. Some experiments illustrating selective masking by an oxide layer against diffusions are also described, the masking action against Cd having been found to be more effective.

Large Scale Integration: Benefitting the System Designer, W. A. Notz, E. Schischa, J. L. Smith and M. G. Smith, *Electronics* **40**, No. 4, 130-141 (February 20, 1967).

This paper discusses the trade-offs that must be considered by the designer who wishes to use LSI.

Light Emitting Semiconductors, F. F. Morehead, *Scientific American* **216**, No. 5, 109-122 (May, 1967).

A variety of electron-exciting mechanisms can be used to induce luminescence in crystals of semiconducting compounds. Among the applications of this capability are efficient solid-state lasers.

Magnetic and Optical Properties of Transparent RbNiF₃, M. W. Shafer, T. R. McGuire, B. E. Argyle and G. J. Fan, *Applied Physics Letters* **10**, No. 7, 202-204 (April 1, 1967).

Magnetic and optical data on single crystal RbNiF₃ are presented. We conclude this material is ferrimagnetic, rather than antiferromagnetic as previously reported, with a transition temperature of 139°K and a saturation moment of 21 emu/g at 4.2°K. The basal plane is the preferred plane and the out of plane anisotropy is 10⁶ ergs/cc. The Faraday rotation measured along the c-axis at 77°K and 80% of magnetic saturation exhibits a peak value of 400 degrees per cm at a wavelength of 4950 Å and values of 250 to 50 degrees per cm in the region 5000 to 6000 Å where the optical absorption is lowest.

Magnetocrystalline Anisotropy of Single-Crystal Europium Oxide, N. Miyata* and B. E. Argyle, *Physical Review* **157**, No. 2, 448-451 (May 10, 1967).

The first order cubic anisotropy constant K₁ in EuO single crystal was measured as a function of temperature and applied field by the static torque method. The value at T = 0°K is

K₁(0) = -(4.36 ± 0.1) × 10⁵ ergs/cm³. The variation of K₁ with T and H is uniquely described by the behavior of the measured magnetic moment σ(H, T). The observed relationship between K₁(H, T)/K₁(0, 0) and σ(H, T)/σ(0, 0) is explained by a theory of single-ion interaction with the cubic crystal potential. The cubic crystal field splitting parameter b₄ = (21.2 ± 0.5) × 10⁻⁴ cm⁻¹/ion obtained from K₁(0) is compared with results for Eu⁺⁺ ions in various other materials.

* Yokohama National University, Minamiku, Yokohama, Japan.

Magneto-Elastic Coupling in RbMnF₃,[†] D. E. Eastman, *Physical Review* **156**, No. 2, 645-654 (April 10, 1967).

Magneto-elastic (ME) coupling effects in the simple cubic antiferromagnet RbMnF₃ have been studied by observing shifts in antiferromagnetic resonance (AFMR) frequency and changes in AFMR line shape with the application of axial stress. Antiferromagnetic resonance in a two-sublattice antiferromagnet with a general anisotropy and ME interaction is analyzed. Formulas for the evaluation of ME constants of a two-sublattice cubic antiferromagnet are presented. ME constants of RbMnF₃ have been determined as a function of temperature from measurements of AFMR in single-crystal specimens under applied stress. The spin-lattice strain coefficients in the spin Hamiltonian for S-state Mn²⁺ in RbMnF₃ have been determined from experimental ME constants and calculated magnetic dipolar ME constants. Large changes in the static and dynamic response of low-anisotropy RbMnF₃ can be effected by the application of stress; via ME coupling, applied stress can change both the form and magnitude of the total anisotropy. The measured AFMR linewidth of RbMnF₃ at low temperatures is shown to be due to inhomogeneous strain broadening. The intrinsic relaxation linewidth is estimated to be less than 5 Oe.

[†] Work supported in part by the U. S. Air Force Office of Scientific Research of the Office of Aerospace Research under Contract No. AF 49(638)-1379.

The Measurement of Infrared Dispersion in Solids by a Method Based on Small Particle Scattering, B. Welber, *Applied Optics* **6**, No. 5, 925-928 (May, 1967).

A method of measuring the components of the complex index of refraction of solids near the reststrahlen region is described. The method is based on the scattering of electromagnetic radiation by small particles, and it is applied here to the cases MgO, LiNbO₃, CdF₂, and PbF₂.

Measurement and Simulation of the Computer Environment, T. W. Steading and J. N. Paulson, *Institute of Environmental Sciences National Technical Meeting*, pp. 275-283, (April 10, 1967).

This paper describes three field investigations made by IBM which resulted in better definitions of earth environmental parameters of man-operated commercial and industrial computers. The environments of interest were floor vibration, airborne dust, and conducted electrical switching transient noise. The techniques used in defining these environments, as well as experimental methods used in simulating them, are described. General summaries derived from the collected data are presented.

Measures That Vanish on Half Spaces, B. Weiss, *Proceedings of the American Mathematical Society* **18**, No. 1, 123-126 (February, 1967).

Microwave Investigation of the Small Gap Anomaly in Lanthanum, W. A. Thompson, *Physics Letters* **24A**, No. 7, 353-354 (March 27, 1967).

This study shows that in fcc lanthanum the measured ratio of superconducting energy gap to transition temperature strongly depends on annealing treatment.

Modular Approach to System Design, W. J. Schuelke, *Automation* **14**, No. 4, 77-83 (April, 1967).

This paper describes some considerations to be taken in the modular approach to system design. Effective use of modular design can extend the usefulness of equipment and delay its obsolescence. Examples from the manufacture of SLT, IBM's hybrid integrated circuits, are given.

Moiré Study of Anticlastic Deformations of Strips with Tapered Edges, W. E. Nickola, H. D. Conway* and K. A. Farnham, *Experimental Mechanics* **7**, No. 4, 168-175 (April, 1967).

When a thin elastic strip is bent, anticlastic deforming of the cross section takes place, and the edges move away from the center of curvature. This effect can have serious consequences in several applications. However, it has been found that the magnitudes of the deformations can be very greatly reduced if the concave edges of the bent strip are tapered.

The proportions of the tapers have already been worked out theoretically so as to optimize the reduction in anticlastic deformation in any given strip bent to a known radius of curvature. The main purpose of this paper is to verify the theoretical deformations for optimally tapered strips by experiments using the moiré method.

* Professor, Dept. of Theoretical and Applied Mechanics, Cornell University, and Consultant, IBM.

A New Approach to Technical Writing, P. Tyner, *STWP 14th International Technical Communications Conference Proceedings*, pp. 92-1 to 92-6 (1967).

A brief analysis of the undefined and conflicting role of the technical writer in the computer manufacturing industry is given. Historical development of documentation needs is described.

New Machines for the Reading of Handwritten Symbols and Printed Characters, H. van Steenis, *Informatie* **9**, No. 5, 91-100 (May, 1967).

This paper is an introduction to the IBM 1287 and IBM 1975 with special emphasis on the character recognition aspects and technologies of both systems.

A Note on State Minimization of Asynchronous Sequential Functions, M. C. Paull and G. Waldbaum, *IEEE Transactions on Electronic Computers* **EC-16**, No. 1, 94-97 (February, 1967).

A procedure is described for minimizing the number of states in an asynchronous sequential function when the restriction exists that the input cannot change while the sequential function is in an unstable state. Furthermore, a procedure is described for minimizing the number of states in a sequential function when

the restriction also exists that each output can change at most once during the time required for a transition from one stable state to another.

On the Numerical Integration of a Symmetric System of Difference-Differential Equations of Neutral Type,* R. K. Brayton and R. A. Willoughby, *Journal of Mathematical Analysis and Applications* **18**, No. 1, 182-189 (April, 1967).

* The results reported in this paper were obtained in the course of research jointly sponsored by the Air Force Office of Scientific Research (Contract AF 49(638)-1474) and IBM.

Numerical Stability of Difference Equations with Matrix Coefficients, B. Dejon, *SIAM Journal on Numerical Analysis* **4**, No. 1, 119-128 (March, 1967).

In this paper we consider the homogeneous difference equation

$$\sum_{j=0}^k \alpha_j y_{n-j} = 0, \quad n = k, k+1, k+2, \dots,$$

with initial values

$$y_j = q_j, \quad j = 0(1)k-1.$$

The y_j are d -component column vectors, the α_j are $d \times d$ matrices independent of n . We derive algebraic criteria for numerical stability of the difference equation, which is understood in the sense that the solution $\{y_j\}$ and its difference quotients up to order $s \in \{0, 1, 2, 3, \dots\}$ depend continuously on the initial values $\{q_j\}$. This generalizes the well-known case where $s = 0$ and the α_j are diagonal matrices.

An Occupancy Discipline and Applications, A. G. Konheim and B. Weiss, *SIAM Journal of Applied Mathematics* **14**, No. 6, 1266-1274 (November, 1966).

140-MHz-Kettenverstärker mit Feldeffekttransistoren (A 140-MHz distributed amplifier with FET transistors), A. Moser, *Internationale Elektronische Rundschau* **21**, No. 5, 109-115 (1967).

The field-effect transistor as high input-impedance voltage-amplification device permits circuit design similar to that of vacuum tubes. Owing to its three-electrode structure, such elements are not suitable for extremely wide-band amplifiers. Instead, an amplifier stage consisting of two source-coupled FET elements is implemented in a distributed structure. The design and construction of a distributed amplifier with 140 MHz bandwidth is discussed.

Orientalional Order in Dipolar Liquids,* A. Szoke,** E. Courtens, and A. Ben-Reuven,** *Chemical Physics Letters* **1**, No. 3, 87-90 (May, 1967).

Light scattering experiments and NMR relaxation measurements have been performed on liquid nitrobenzene, and on mixtures of nitrobenzene with benzene and carbon tetrachloride. The results indicate that local order prevails in pure nitrobenzene, and that the nitrobenzene-benzene mixtures have an ordered microstructure, whereas mixtures with carbon tetrachloride are disordered. The relevance of these measurements to the microstructure of aromatic dipolar liquids is discussed.

* Work performed at the Department of Nuclear Physics, Weizmann Institute of Science, Rehovoth, Israel.

** Department of Nuclear Physics, Weizmann Institute of Science, Rehovoth, Israel.

Peak-Hold Circuit, P. P. Tong, *EEE* 15, No. 15, 164-166 (March, 1967).

In control systems and instrumentation, it is often necessary to hold the peak voltage of a short-duration analog signal for a longer period of time. This circuit receives a short-duration analog voltage as input and holds the peak magnitude of the input for any required period up to several hundred milliseconds.

"Perfect Epitaxy" of Silicon Films on Silicon as Seen in Large-Area X-ray Topographs, G. H. Schwuttke, *Advances in Vacuum Science and Technology: Transactions of the Third International Vacuum Congress* 2, (Part 3), 301-308 (1966).

A novel x-ray technique and its application to semiconductor thin-film problems is described. The technique is capable of recording large-area transmission topographs of crystal slices as processed in modern semiconductor device technology. The method is non-destructive and, therefore, thin films on single-crystal substrate can be examined after each processing step. In this paper the technique is actually applied to the problems of "perfect epitaxy." The perfection of the interfacial region is determined for silicon films on silicon, interfacial dislocations are revealed and finally the nature of these defects is determined.

Performance Criteria for the Comparison of Modulation Methods, R. F. Filipowsky, *SWIECO Record of Technical Program Papers, Nineteenth Annual Southwestern Conference and Exhibition*, pp. 20-5-1 to 20-5-8 (1967).

A method is presented for the evaluation of the information transmission capability of different modulation systems when compared under well-defined transmission conditions. The method is applicable to analog, sampled, and binary or non-binary modulation, and it permits the direct comparison of mathematical models with laboratory tests and field tests.

This paper reports a further extension of R. W. Sanders' effort to arrive at a suitable normalization of the key parameters used in comparisons of such modulation systems. One novel feature in this paper is the definition of a magnitude called "bit density" which is related to, but not identical with, the α parameter of Sanders. The bit density is based on the practical magnitude of the transmission rate, which can be easily measured, while the α parameter is based on the analytical magnitudes of signal and noise entropy that depend on the statistics of the information and, therefore, cannot be easily measured.

An expansion of R. W. Sanders' definition of a communications efficiency is explained. It leads, under certain well-defined assumptions, to a system of three performance criteria which are still closely related to the usually applied signal-to-noise ratio and to the transmission rate, yet which permit a normalization for the comparison of the many modulation and coding methods which are now in use. A graphical presentation, the utility chart, will permit the practical engineer to make instant use of these performance criteria.

Photo-Ionization of Two-Phonon-Excited Singlet Excitons in Anthracene,* E. Courtens, A. Bergmann,** and J. Jortner,** *Physical Review* 156, No. 3, 948-950 (April 15, 1967).

The results of an experimental study of the photoconductivity induced by a giant-pulse ruby laser in crystalline anthracene lead to the following conclusions: (1) Up to laser intensities of 5×10^{25} photons $\text{cm}^{-2} \text{sec}^{-1}$, charge carriers are generated by a

three-photon process. (2) The dominant mechanism for the production of charge carriers involves the photo-ionization of singlet-exciton states. (3) A cross section of 10^{-19} cm^2 at $\lambda = 6940 \text{ \AA}$ was determined for the photo-ionization of singlet-exciton states. (4) A bimolecular rate constant of $(5 \pm 3) \times 10^{-7} \text{ cm}^3 \text{ sec}^{-1}$ for charge-carrier recombination in crystalline anthracene was directly determined.

* Work performed when E. Courtens was at the Weizmann Institute of Science, Rehovoth, Israel.

** Department of Chemistry, Tel-Aviv University.

Plane Thermal Stress at an Insulated Hole Under Uniform Heat Flow in an Orthotropic Medium, W. T. Chen, *Transactions of the ASME, Journal of Applied Mechanics* 80, No. 1, 133-136 (March, 1967).

When a uniform heat flow in an infinite orthotropic solid is disturbed by the presence of a long circular insulated cavity, local intensification of the temperature gradient occurs in the neighborhood of the cavity. This paper describes a study of the stress field induced by the temperature distribution. The linear plane (plane stress or plane strain) thermoelastic problem is solved by using the complex variable technique. The analysis may also be used for other steady-state thermal stress problems in an orthotropic medium.

Problems Related to the Fabrication of Copper Clad Polyimide Glass Laminates, J. M. Schiller and M. N. Turetzky, *Society of Plastics Engineers 25th Annual Technical Conference, Technical Papers*, pp. 905-910 (1967).

A polyimide multilayer was successfully produced consisting of three copper layers—the top layer is 3-oz and the next two, 2 oz—they are laminated with a minimum polyimide thickness to a 1/2 in. thick copper block; the external dimensions of the piece are 4 × 4 in. This laminate has been made both with and without glass cloth reinforcement. The recommended materials and techniques are discussed in this report. Briefly the steps involve coating by doctor blading, thermal staging of the coating up to 200°C, and then lamination at 300°C and 1000 psi for forty-five minutes. The laminates can be characterized as exhibiting excellent uniformity of dielectric thickness in layers as thin as two mils; demonstrating freedom from internal voids, external blisters and other damage to the copper surface, and skin precipitation; limited to lamination areas of about 4 × 4 in.; and exhibiting the unexplained property of reduced bond strength in the internal planes of a multilayer.

Radiographic Screening of Relays to Ameliorate High Reliability Devices, J. E. Landers and M. W. Tatum, *Proceedings of the Fifteenth Annual National Relay Conference*, pp. 3-1 to 3-6 (1967).

Radiographic inspection has been used successfully to screen semiconductors and resistors. It has been found that this technique is now useful in the area of relay screening. This paper describes the techniques used, the problems encountered, and the solutions considered with regard to utilization of the radiographic screening process. Slides of x-rays showing various discrepancies that can be detected by radiographic inspection are presented. The following areas are covered: (1) Equipment required (x-ray, viewing, etc.), (2) X-ray techniques (exposure factors, optimum positioning of device for x-ray), (3) Quality control (equipment, techniques related to types and quality of film, film processing and handling), and (4) Reject criteria (detectable contamination, lead wire discrepancies, structural discrepancies).

Reflections on the Design of a CAI Operating System, E. N. Adams, *Proceedings, Spring Joint Computer Conference*, pp. 419-424 (1967).

A time-shared general purpose computer programmed to operate in conversational mode may be used as a vehicle for computer aided instruction (CAI). For the CAI application certain functions of the system program are especially important, in particular those affecting flexibility of display, system response time, ease with which complex programs may be prepared, proofed, and revised, and the versatility and efficiency of transaction recording and analysis. Some qualitative generalizations about user programs and operational requirements have been suggested by experience with the IBM 1440 Coursewriter, the experimental compiler and operating system for the IBM 7010-1440, and the IBM 1500 Coursewriter II. A few of these are discussed in terms of their implications for the monitor, service programs, and utilities of the system. Particular attention is given to optimizing allocations of storage among user and system functions for the kind of user programs we have seen. Some discussion is also given of entry and compiling, logging and analysis of transaction data, and avoiding or recovering from system malfunctions.

Reliable Decisions from Unreliable Measurements, F. R. Van Wagner, *Electronic Engineer* 26, No. 4, 50-56 (April, 1967).

The development and production of modern electronic equipment frequently requires high-precision measurements to determine if engineering requirements are being met. Often existing measurement techniques are not sufficiently precise to allow reasonable confidence in accept-reject, in-tolerance, out-of-tolerance decisions based on those measurements. This paper presents a technique of improving the effective precision of a measurement method to any desired level through a strategy of repeated measurements and artificial decision limits. Since a certain pattern of repeated measurements can take the place of expensive high-precision instrumentation, the relative costs of these two alternatives can be the basis of a rational choice between the two. The criteria for measurement reliability are the risks of making wrong decisions. By using one of the graphs in the paper, the analyst can determine the magnitude of the risks he will encounter if he ignores the measurement reliability problem. A simple calculation, made once for each experimental situation, can provide a test value whereby he can decide after taking a measurement whether to take the observation at face value or to apply a repeated measurement strategy. A complete set of graphs is included to make application of the technique practical in nearly any situation involving two-sided tolerance limits.

Scanning with Lasers, R. A. Myers, *International Science and Technology*, No. 65, 40-51 (May, 1967).

Overcoming the relative imperturbability of light in a practical way can lead to better techniques of processing information by precise control of a moving spot of light. Deflecting laser light is now possible in the laboratory using electron beams electro-optic crystals, or acoustic cells. An optical-phased array is possible but demonstrations of its principles disclose formidable problems in achieving precise manufacturing tolerances. But better materials and manufacturing techniques are still needed. A new kind of laser resonator, the scanlaser, holds promise of combining the most useful features of the laser and the cathode-ray tube. Instead of trying to deflect light itself, an electron beam is deflected to any point on an electro-optic mirror where

ever it is desired to cause a spot to "lase." Because of the extremely small spot for scanning, it may lead to high-resolution optical radar, holographic memories, large-screen displays, optical switching, and more precise control of the manufacturing process for microcircuits.

Selecting H-F Linear DC Amplifiers, J. W. McCullough, *Electronic Engineer* 26, No. 4, 73-78 (April, 1967).

Linear dc amplifiers are becoming more and more important in an engineer's design portfolio. With integrated circuits, the cost, function, and reliability of these are greatly improved. Hence, the engineer should be aware of the capabilities, advantages, and limitations of a linear dc amplifier. By using the chart showing the approximate amplifier transfer function, exact transfer function, dc offset equations, input and output impedance, frequency response (small signal), noise response, and slewing rate most of the types of linear dc amplifier applications can be analyzed.

Simultaneous Determination of Tin and Lead Using Cyclic Stationary Electrode Polarography, S. L. Phillips, *Analytical Chemistry* 39, No. 4, 536-537 (April, 1967).

The anodic stripping method of electrochemical analysis has been applied to the simultaneous determination of tin and lead in an unstirred solution. Using a supporting electrolyte of 2M formic acid, 2M ammonium formate and 0.005-0.020M pyrogallol, calibration curves were obtained in the 10^{-6} M concentration range.

Small-Mechanism Stress Analysis, R. L. Lyon, *Experimental Mechanics* 7, No. 5, 19A-23A (May, 1967).

This paper describes a number of applications of experimental stress analysis in small mechanical structures, making use of resistance-based strain-gage transducers.

Spectrochemical Analysis of Abrasive Materials, T. S. Long, *Developments in Applied Spectroscopy*, (Proceedings of the 16th Annual Mid-America Spectroscopy Symposium) 5, 307-316 (April, 1967).

Analysis of abrasive feed rolls used in IBM machines by a powder dc-arc technique is described. The feed rolls require special analysis because of the large amounts of aluminum, silicon, iron, and titanium oxides (2%-100%). In this method, the sample was ground to a powder form and mixed with graphite and metallic germanium. The addition of graphite and germanium as buffers produced a very stable arc in which a homogeneous mixture was attained early in the excitation, resulting in reproducible spectral lines. Germanium also served as the internal standard. The sample was placed in a graphite cup and excited with a 10-A dc arc. The National Bureau of Standards series 76, 77, 78 were successfully used in place of synthetic standards. The analytical lines, apparatus, and excitation parameters are described in detail. Typical concentration curves are shown and the precision, in which the average coefficient of variation for all elements is less than 12.0, is also given.

Stimulated Electronic Raman Scattering, P. P. Sorokin,* N. S. Shiren, J. R. Lankard,* E. C. Hammond† and T. G. Kazyaka, *Applied Physics Letters* 10, No. 2, 44-46 (January 15, 1967).

Stimulated electronic Raman scattering in potassium vapor is observed. The primary source was a nitrobenzene Raman-shifted ruby laser. The secondary beam frequency occurs 58 cm^{-1} to the high energy side of ν_p .

* Partially supported by Army Research Office, Durham, N. C.

† Presently at Morgan State College, Baltimore, Md.

String Similarity and Misspellings, C. N. Alberga, *Communications of the ACM* **10**, No. 5, 302-313 (May, 1967).

The problem of programming a computer to determine whether or not a string of characters is a misspelling of a given word was considered. A number of algorithms were evaluated—some proposed by other writers, some by the author. These techniques were tested on a collection of misspellings made by students at various grade levels.

While many of the methods were clearly unsatisfactory, some gave as few as 2.1 percent incorrect determinations.

A Study of Remote Industrial Training via Computer-Assisted Instruction, H. A. Schwartz and H. S. Long, *Journal of Applied Psychology* **51**, No. 1, 11-16 (February, 1967).

During the latter half of 1965, several field engineers received their required training in new computer technology through remote computer-assisted instruction (CAI). Students at terminals located in 4 major cities communicated, through Tele-processing facilities, with a computer system located centrally. Students' examination scores, course completion times, and attitudes were compared with those of other students who received the material through self-study texts in use at the time. CAI students scored lower on 1 part of the examination, but completed the course in considerably less time than the self-study students. Attitude scores were somewhat equivocal. Students who had been exposed to both CAI and self-study texts indicated a strong preference for the former. When compared to a "regular classroom" type of presentation, however, the self-study students rated their method slightly higher than did the CAI students. CAI students' attitudes appear to be related to the availability of assistance when course material problems are encountered. Additional findings from locally trained CAI students are presented in support of this interpretation.

Study Suggests Connector Sealing Techniques for Extended Mission Computers, M. Ball and F. H. Hardie, *Electronic Packaging and Production* **7**, No. 5, 103-113 (May, 1967).

Various methods of sealing an entire space computer while providing limited circuit exposure during maintenance were examined, as were methods for sealing the individual replaceable modules and their connectors. In either case, connector protection was considered critical because of the adverse space environment.

Theory and Practice of RF Sputtering, P. D. Davidse, *Vacuum* **17**, No. 3, 139-145, (March, 1967).

The basic principles of RF sputtering of insulators and their properties are reviewed and an RF sputtering system is described. The effect of various process parameters on deposition rate and film properties is also given. RF sputtering of metals can be achieved by capacitively coupling the power supply to the metal electrode. With this technique, it is possible to deposit insulator films through RF reaction sputtering at rates significantly higher than those obtainable through DC methods.

Thermal Phonon Transport in n-Type Ge and Si,* M. Pom-erantz, *Physics Letters* **24A**, No. 2, 81-82 (January 16, 1967).

The thermal conductivity and thermoelectric power of *n*-type Ge are known to depend on the chemical species of the donor. This is explained in terms of phonon scattering by a relaxation process of donor electrons.

* Supported in part by U. S. Army Electronics Command, Fort Monmouth, N. J., under Contract DA 36-039 ACM-02280(E).

A Time-Sharing System for Business Operations, G. F. Duffy, *Systems & Procedures Journal* **18**, No. 3, 20-24, (May-June, 1967).

Administrative terminal systems have been demonstrated to be successful in such operations as those that: require file maintenance on a real-time basis at frequent intervals; require information retrieval on a real-time basis; require accurate hard copy, either on or off-line; require minimum turn-around time between entry and output.

Trigonometric Product Waveforms as the Basis of Orthogonal or Suborthogonal Sets of Signals, R. F. Filipowsky, *Proceedings of the National Telemetry Conference*, pp. 283-289 (1967).

After a review of the existing classes of orthogonal sets of waveforms and their application, the author discusses briefly the presently accepted definitions of the bandwidth-time product of band-limited waveforms. Several distinct mathematical approaches are then mentioned which led in the past to the definition of orthogonal sets of waveforms. A long list of references is interwoven with this short history of signal sets. In the second part of the paper a set of waveforms is introduced that is defined by the *p* factor products of the trigonometric functions (sine or cosine) of harmonically related frequencies. If *p* = 2, these functions become identical with a double sideband waveform having an integer relationship between the carrier frequency and the sine (or cosine) modulating frequency. For *p* > 2, one may consider this new set as the result of a multiple double sideband modulation process where a modulated waveform, in tandem product circuits, is again and again modulated, and where all the modulating frequencies are harmonically related to each other and to the carrier. One subset of these product waveforms is an orthogonal subset. Tables of functions, waveform pictures, and lists of advantageous characteristics of these waveforms conclude the paper.

Tunneling Studies on the Group V Semimetals and the IV-VI Semiconductors, L. Esaki, *Journal of the Physical Society of Japan* (Proceedings of the International Conference on the Physics of Semiconductors) **21** (Supplement), 589-597 (1966).

The band structures of the group V semimetals and their alloys and the IV-VI compound semiconductors have been explored with the technique of tunneling through a thin insulating layer. We have obtained not only corroborative but also entirely new information on the band edge energies of these materials; namely, a number of band edges above and below the Fermi energy in Bi and Bi Sb alloys and the thermal energy gaps, the Fermi energies, and the electron affinities in SnTe and GeTe. In addition, a negative resistance, arising from the voltage dependence of the tunneling probability, and also a bump, believed to be related to the excitation of plasma oscillations, were discovered in SnTe and GeTe tunneling.

Ultrasonic Attenuation in the Heisenberg Paramagnet,*
H. S. Bennett,** and E. Pytte, *Physical Review* **155**, No. 2,
553-562 (March 10, 1967).

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