January through February, 1957

# IBM Technical Papers Published in Other Journals

**The Analytical Design and Evaluation of Electromagnets,** M. J. Kelly and J. E. Wallace, *AIEE Communications and Electronics,* **675** (January 1957).

This paper describes a method for the accurate computation of the operating characteristics of electromagnets, such as used in relays and other electro-mechanical devices. The dynamic solution involves the use of techniques applicable to digital computers. The evaluation of the computer solutions offers a means of obtaining the optimum magnet design for a given device. The method eliminates the need for building successive models for testing and evaluation.

**Atomic Scattering Factors and the TFD Atomic Model,** L. H. Thomas and K. Umeda,* *Journal of Chemical Physics,* **26,** No. 2, 293 (February, 1957).

Using the *TFD* electron density, recently published by one of us (*T*), the atomic scattering factor $f_0$ has been calculated for neutral atoms as well as for singly through quadruply ionized positive ions with intermediate atomic numbers on the IBM 607 and 650. The $f_0$ values thus obtained for Ar and $Cu^+$ agree qualitatively with those calculated from the Hartree-Fock fields recently by MacGillavry et al. The experimental fact has been again confirmed, that the $f_0$ value is not much influenced by the state of ionization. The effect of exchange has been displayed by the deviation of the *TFD* curve of the atomic scattering factor per electron $f_0$ versus the Bethe variable $\xi$, from the *TF* universal curve. The *TFD* curve of $f_0$ versus $Z$ for a definite state of ionization has a slight minimum at a certain value of $Z$ which increases with decreasing scattering angle and tends finally at vanishing scattering angle to a definite limiting value just corresponding to the maximum of $(r^2)_{Av}$.

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**Automation in Forecasting,** Grace Sacks, *Management Science* **3,** 206 (January, 1957). (Abstract).

Existing digital computer methods for use in forecasting and trend analysis are presented. Emphasis is on problems which require the larger electronic data-processing equipment. Methods for the analysis of time-series and calculation of multiple linear and nonlinear regression are discussed. Capacities, accuracies and computing times are included.

**Controlling the Equipment Cooling System for the Prototype SAGE Computer,** C. L. Waite, *Taylor Technology,* **9,** No. 2, 20 (winter issue, 1957).

A description is given of the pneumatic control system used for control of the cooling system for the prototype SAGE computer.

**The Detection and Identification of Symmetric Switching Functions with the Use of Tables of Combinations,** M. P. Marcus, *Transactions of the PGEC,* **237** (December, 1956).

This paper presents two methods of detecting and identifying general symmetric switching functions, with the use of tables of combinations. Symmetric switching functions lead to relay contact networks which are much more economical than the best series-parallel circuit. A particular class of symmetric functions that relate to the *"m* out of *n"* network has been investigated; but treatment of the general symmetric function has been omitted from almost all the work in this field.

**The Erosion of Electrical Contacts by the Normal Arc,** W. B. Ittner, III, and H. B. Ulsh, *Proceedings IEE,* **104,** Part **B,** No. 13, 63 (January, 1957).

The cathode material transfer under the action of the "normal arc" has been measured for a number of elements and alloys. In all cases auxiliary circuits were used to record the accumulative arc duration and the voltage/current characteristics of the arc, from which the total arc energy as well as the total charge passed in the arc could be accurately calculated. Within the experimental errors, the material transfer from the cathode was found to be directly proportional to the total charge passed in the arc—a relationship first proposed by R. Holm. It is shown that, for most practical purposes, the cathode "normal arc" transfer can be calculated with a reasonable accuracy according to the formula given by Llewellyn Jones.

**Evaluation of Reliability for Parallel Redundant Systems,** T. L. Burnett, *Proceedings of the Third National Symposium on Reliability and Quality Control,* 92-95 (January, 1957).

One of the methods available to electronic designers for increasing the reliability of systems comprised of components presently available to the industry is to design the system in such a manner that certain of the components are duplicated two or more times. When a failure occurs in a functioning component, automatic switch is provided to switch to one of the duplicate elements. In this paper, mathematically formulae are presented showing system reliability to be a function of the reliability of the individual components and of the switching devices. The system reliability increases asymptotically with an increase in redundancy but is limited by the unreliability of the increasingly complex switching arrange-

ment. Two configurations are considered: systems in parallel and components in parallel for both relay type switches and rotary type switches.

**Observations of the Failure of Conservation of Parity and Charge Conjugation in Meson Decays: The Magnetic Moment of the Free Muon,** R. L. Garwin, L. M. Lederman* and M. Weinrich,* *Physical Review 105,* 1415 (February 15, 1957).

The nonconservation of parity and charge-conjugation is established by exhibiting by magnetic precession of stopped muons a large space asymmetry in the emission of the decay electrons from polarized muons which were obtained by forward decay-in-flight of pions from the cyclotron. The experiment proves that in all four decays

$\pi^{\pm} \rightarrow \mu^{\pm} + \nu$

and $\mu^{\pm} \rightarrow e^{\pm} + 2\nu$

there is nonconservation of parity and charge-conjugation as predicted by Lee and Yang. The curve of electron counting rate vs. magnetic field in a fixed counter at fixed delay time agrees well with a $g$-value of $+ 2.00 \pm 0.10$ for the $\mu^{+}$ and with an angular distribution $1 + a \cos \theta$, with $a = -0.33 \pm 0.03$, while a negative $g$-value is observed for the $\mu^{-}$. Additional evidence for $g \sim + 2.0$ was obtained from the equality of spin precession and cyclotron frequencies of the mu meson in flight.

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**Organizing for Reliability,** R. E. Kuehn, *Proceedings of the Third National Symposium on Reliability and Quality* Control, 123-125, (January, 1957).

Since the ultimate reliability of the product depends so vitally on the decisions made during the earliest system planning, the reliability organization should be set up as early as possible in the project life. In some companies the reliability organization is functional rather than part of the project organizations and provides basic reliability services to all projects. The functional organization insures that the reliability service is available from the initial concept of the product and can contribute to the initial planning. It has the advantage of developing an experienced group with greater possibilities for transcontinuity of key people and makes possible the use of more specialists than a project organization can justify.

**Paramagnetic Resonance Detection along the Polarizing Field Direction.** G. Whitfield and A. R. Redfield, *Bulletin of the American Physical Society,* Series II, **2,** 36 (January 30, 1957). (Abstract).

Several writers* have suggested modifying the Bloch equations so that the magnetization will tend to relax toward the instantaneous applied magnetic field rather than the fixed field. For the case where a fixed field ($H_z$) and a perpendicular circularly polarized *rf* field ($H_1$) are applied to a sample, both the modified and unmodified Bloch equations have exact steady state solutions which differ from each other appreciably when $H_z$ is smaller than $H_1$ or the line width in gauss. In the case where $H_z = 0$, the modified equations give a finite dc magnetization in the *z direction* ($M_z$) and the unmodified equations give $M_z = 0$. The $z$ component of the electronic spin magnetization of diphenyl pycril hydrazil was measured, with $H_z$ ranging from $+20$ to $-20$ gauss and with a circularly polarized rf up to 6 gauss at 19.5 mc. The dc magnetization was observed by turning the rf on and off at 280 cps and picking up the resultant changes in magnetization with a 30-thousand-turn coil oriented along the $z$ axis. The measurements agree with the predictions of the modified Bloch equations. In particular, a clear indication of the existence of a $z$ component of magnetization was obtained when $H_z = 0$.

*Codington, Olds, and Torrey, *Phys. Rev.* **95,** 607 (1954); M. A. Garstens and J. I. Kaplan, *Phys. Rev.* **99,** 459 (1955).

**The Second Fundamental Problem of Elasticity Applied to a Plane Circular Ring,** W. A. Gross, *Journal of Applied Mathematics and Physics (ZAMP),* **VIII,** 1957, Fasc. 1, pp 71-73.

The general solution of the second fundamental problem, that in which boundary displacements are specified, for a plane circular ring is given using the complex variable method of N. I. Muskhelishvili. The solution of a particular problem, that of a ring with fixed outer boundaries and a rigidly translated inner boundary, is compared with the solution of H. Reissner. (Work done at Bell Telephone Laboratories.)

**The Vernier Time-Measuring Technique,** Robert G. Baron, *Proceedings of the IRE,* **45,** No. 1, 21 (January, 1957).

This paper describes a measuring technique which is the electrical analog of the mechanical vernier scale. A system is presented that will measure the time between two pulses, which jitter relative to each other and occur at some random rate, accurate to 10 m$\mu$sec. Pulse circuitry is employed to implement the system.

**VHF Pulse Techniques and Logical Circuitry,** D. E. Rosenheim and A. G. Anderson, *Proceedings of the IRE,* **45,** No. 2, 212 (February, 1957).

Techniques and components for use in systems handling pulses of 10-millimicrosecond width have been investigated. Bandwith requirements have led to the use of secondary emission pentodes in amplifier service. The limitation of time delay in feedback type circuitry have made necessary the use of special logical reshaping circuits. A test program on commercially available semiconductor diodes resulted in the selection of high-conductance, gold-bonded junction diodes for use in switching circuits. Multivibrator circuits have been designed for gating and delay functions. Electromagnetic delay lines of both the coaxial and helical-wound types have been used for delay and for pulse generation. These components have been applied to the design of an arithmetic unit which performs binary addition, multiplication, and dynamic storage at a pulse repetition rate of 50 megacycles per second.