NATIONAL BUREAU OF STANDARDS REPORT

4658

PROJECTS and PUBLICATIONS
of the
APPLIED MATHEMATICS DIVISION

A Quarterly Report

January through March, 1956

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section is engaged in specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant reports and publications, appears on the inside of the back cover of this report.

Electricity and Electronics. Resistance and Reactance. Electron Tubes. Electrical Instruments. Magnetic Measurements. Process Technology. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat and Power. Temperature Measurements. Thermodynamics. Cryogenic Physics. Engines and Lubrication. Engine Fuels.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment. AEC Radiation Instruments.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Gas Chemistry. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Organic Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion.

Mineral Products. Porcelain and Pottery. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Heating and Air Conditioning. Floor, Roof, and Wall Coverings. Codes and Specifications.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. Components and Techniques. Digital Circuitry. Digital Systems. Analogue Systems.

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services.

Radio Propagation Engineering. Frequency Utilization Research. Tropospheric Propagation Research.

Radio Standards. High Frequency Standards. Microwave Standards.

● Office of Basic Instrumentation   ● Office of Weights and Measures

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*Only unclassified projects are included in this report.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

II.0

NBS REPORT

4658

PROJECTS and PUBLICATIONS
of the
APPLIED MATHEMATICS DIVISION

January through March, 1956

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

APPLIED MATHEMATICS DIVISION

January 1 through March 31, 1956

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Leon Feldman, B.A.
*Peter Henrici, Ph.D.

*Fritz Oberhettinger, Ph.D.
Edith N. Reese, B.A.
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**Robert Stoneley, Sc.D.
*John L. Synge, Sc.D.

*Under contract with The American University **Guest Worker ***On leave of absence

Status of Projects

March 31, 1956

1. NUMERICAL ANALYSIS

RESEARCH IN THEORIES OF DISCRETE STRUCTURES
Task 1100-10-5116/56-159

Origin: NBS   Authorized 9/30/55
Sponsor: Office of Naval Research
Manager: O. Taussky-Todd
Full task description: July-Sept 1955 issue, p. 1

Status: CONTINUED. O. Taussky continued her investigations concerning the higher commutators of a matrix A and its transposed and conjugate A*. For 3x3 matrices examples were constructed which show that the second, fourth, fifth, or sixth order commutator (A,A,...,A,A*) of A and A* can be the first one to vanish. If none of these vanishes, then no commutator of any order will vanish. Group matrices with vanishing fourth order commutators were also studied.

M. Newman and O. Taussky had proved earlier that a unimodular circulant of integers of the form AA' is also of the form CC' when C is again a circulant of integers. They now have shown that the weaker condition of positive definiteness does not suffice for circulants of order $n \geqslant 8$. A manuscript has been prepared.

M. Newman and O. Taussky are studying hermitian matrices and their decomposition into the form AA* where A may be rectangular.

Publications:
(1) On a generalization of the normal basis in abelian algebraic number fields. M. Newman and O. Taussky. Comm. Pure Appl. Math. (New York University) 9, 85-91 (1956).
(2) A note on group matrices. O. Taussky. Proc. Amer. Math. Soc. 6, 984-986 (1955).
(3) The formal power series for log ($e^x \cdot e^y$). K. Goldberg. To appear in the Duke Mathematical Journal.
(4) The number of absolute points of a correlation. A. Hoffman, M. Newman, E. Straus, O. Taussky. To appear in the Pacific Journal of Mathematics.
(5) Some computational problems in algebraic number theory. O. Taussky. To appear in the Proceedings of the American Mathematical Society Sixth Symposium on Applied Mathematics, held at Santa Monica, California, 1953.
(6) Bounds and asymptotic behavior of the coefficients in the series log ($e^x e^y$). K. Goldberg. In manuscript.
(7) Algebraic equations satisfied by roots of natural numbers. E. G. Straus (University of California at Los Angeles) and O. Taussky. To appear in Pacific Journal of Mathematics.
(8) Pairs of matrices with property L, II. T. S. Motzkin and O. Taussky. Trans. Amer. Math. Soc. 80, 387-401 (1955).
(9) Generation and testing of pseudo-random numbers. O. Taussky and J. Todd. To appear in the Proceedings of a Symposium on Monte Carlo Methods, held at Gainesville, Florida, 1954.

(10) On the Hilbert matrix. T. Kato. Submitted to a technical journal.
(11) Commutators of A and A*. T. Kato and O. Taussky. J. Wash. Acad.
     Sci. 46, 38-40 (1956).
(12) Some free subgroups of the modular group. K. Goldberg and M. Newman.
     In manuscript.
(13) Classes of positive definite unimodular circulants. M. Newman and
     O. Taussky. In manuscript.

RESEARCH IN NUMERICAL ANALYSIS AND RELATED FIELDS
Task 1101-10-1104/55-55

Origin: NBS   Authorized 8/13/54
Managers: J. Todd, P. Davis   Revised   8/29/54
Full task description: July-Sept 1954 issue, p. 1

        Status: CONTINUED. H. A. Antosiewicz has continued his work on the
survey of conditions for the stability of solutions of ordinary differential
equations which are based on Lyapunov's second method. Particular emphasis
has been paid to those conditions that guarantee stability "in the large."
Among them and related to them are criteria for the ultimate boundedness
of every solution. The concept of ultimate boundedness is important in
many cases of practical interest: For non-linear differential equations
of the second order it has been investigated previously by G. E. Reuter
and for more general equations by T. Yoshizawa. The latter's method of
attack is closely related to Lyapunov's method.
        P. Davis and Ky Fan have completed the present phase of their
study on inequality and approximation in function spaces. It will probably
be resumed when Professor Ky Fan returns to the Bureau in the summer.
        J. Todd has continued his survey of various topics in the theory
of approximation that are applicable in numerical analysis. Arising out
of this, J. Todd has planned a new tabulation of the Cauer parameters,
with an independent variable different from that used by Glowatski. These
parameters arise in the design of electrical circuits and are expressed
in terms of elliptic functions, the modular parameter of which depends,
in the case of filters for example, on the permissible width of the frequency
band in the pass-and-stop interval.
        K. Goldberg continued his study of iterated convolutions.

        Publications:
(1) Stable systems of differential equations with integrable perturbation
    term. H. Antosiewicz. To appear in the Journal of the London Mathematical
    Society.
(2) On the Lerch zeta function. F. Oberhettinger. To appear in the Pacific
    Journal of Mathematics.
(3) A subroutine for computations with rational numbers. P. Henrici. J.
    Assoc. Comp. Mach. 3, 6-9 (1956).
(4) A direct approach to the problem of stability in the numerical solution
    of partial differential equations. J. Todd. To appear in the Proceedings
    of a Symposium on Partial Differential Equations, held at Berkeley,
    California, 1955.
(5) Some Monte Carlo experiments for computing multiple integrals. P. Davis
    and P. Rabinowitz. To appear in Mathematical Tables and Other Aids to
    Computation.
(6) Abscissas and weights for Gaussian quadratures of high order. P. Davis
    and P. Rabinowitz. J. Res. NBS 56, 35-37 (1956), RP2645.
(7) Numerical experiments in potential theory using orthonormal functions.
    P. Davis and P. Rabinowitz. J. Wash. Acad. Sci. 46, 12-17 (1956).
(8) Complete sequences and approximations in normed linear spaces. P. Davis
    and K. Fan. Submitted to a technical journal.
(9) A matrix with real characteristic roots. K. Goldberg. To appear in
    Journal of Research, NBS.

(10) Note on bounds for determinants. E. V. Haynsworth. In manuscript.
(11) On asymptotic stability. H. A. Antosiewicz. In manuscript.

RESEARCH IN MATHEMATICAL TOPICS APPLICABLE TO
NUMERICAL ANALYSIS
Task 1101-10-5116/55-56

Origin: NBS   Authorized 8/13/54
Sponsor: Office of Naval Research   Revised   8/29/54
Managers: J. Todd, M. Newman
Full task description: July-Sept 1954 issue, p. 5

     Status: CONTINUED. Some experiments in inverting matrices and
solving linear systems (using the floating point routines for these
purposes, described previously) were undertaken by M. Newman and I. Stegun.
It was found that even for matrices of orders as high as 60, round-off
error remained negligible. Comparing these results with those obtained
from fixed point routines, the conclusion seems to be that both time-wise
and accuracy-wise floating point routines are to be preferred. A more or
less detailed description and evaluation of various codes for matrix
operations is being prepared.
     Some new floating point routines for computing such functions as
log x, e^x, have been prepared by M. Newman.
     A. J. Hoffman has completed an expository article (see publication
(22) below) on linear programming, summarizing the highlights of the theory,
computing procedures and applications of the subject.
     Ky Fan, I. Glicksberg (University of Notre Dame), and A. J. Hoffman,
have completed a manuscript (publication (23) below) on systems of inequalities
involving convex functions. Questions relating to the consistency, independence,
and so forth, of a system of inequalities $f_i(x) < 0$, where the f_i are convex
functions defined on a convex set in a real linear space, are shown to be
resolvable almost as simply as the corresponding questions for systems of
linear inequalities that they generalize.
     A. J. Hoffman has shown (in publication (24)) that a simple
combinatorial lemma yields a generalization of a well-known theorem of König
on systems "representing" two partitions of a given set. The lemma states
that if the incidence matrix of points vs. subsets for a given set R and
family of subsets $\{S_1,...,S_m\}$ has the unimodular property that every square
sub-matrix is singular or unimodular, and $0 < \alpha < 1$, then there exists a
set $C \subseteq R$ such that $|\overline{C \cap S_i} - \alpha J_i| < 1$. (Ā denotes the cardinality of the
set A.)

     Publications:
(1) The normalizer of certain modular subgroups. M. Newman. Canadian Math.
    J. $\underline{8}$, 29-31 (1956).
(2) Generalizations of identities for coefficients of certain modular forms.
    M. Newman. To appear in Journal of the London Mathematical Society.
(3) Compactification of completely regular spaces. Ky Fan and F. Wagner
    (University of Notre Dame). In manuscript.
(4) On dominant eigenvalues of positive matrices. T. Kato. In manuscript.
(5) A comparison theorem for eigenvalues of normal matrices. Ky Fan. Pac.
    J. Math. $\underline{5}$, 911-913 (1955).
(6) On generating functions of the Jacobi polynomials. P. Henrici. Pac. J.
    Math. $\underline{5}$, 923-931 (1955).
(7) Error bounds for eigenvalues of symmetric integral equations. H. Wielandt.
    To appear in the Proceedings of the American Mathematical Society Sixth
    Symposium on Applied Mathematics, held at Santa Monica, California, 1953.

(8) On systems of distinct representatives. A. J. Hoffman and H. W. Kuhn. (Bryn Mawr College). To appear in Annals of Mathematics Study 38.

(9) Systems of linear inequalities. Ky Fan. To appear in Annals of Mathematics Study 38.

(10) Systems of distinct representatives and linear programming. A. J. Hoffman and H. W. Kuhn (Bryn Mawr College). To appear in the American Mathematical Monthly.

(11) Dilworth's theorem on partially ordered sets. G. B. Dantzig (RAND Corporation) and A. J. Hoffman. To appear in Annals of Mathematics Study 38.

(12) On "overshoot" in the "furthest hyperplane" method. R. Bryce. In manuscript.

(13) Notes on some scheduling programs. A. J. Hoffman. In manuscript.

(14) On block relaxation. L. S. Joel. In manuscript.

(15) On the minimization of concave and convex functionals. G. B. Dantzig (RAND Corporation), A. J. Hoffman, W. Hirsch (New York University). In manuscript.

(16) The lowest frequency of a free square plate. H. Fujita (University of Tokyo), T. Kato, Y. Nakata (University of Tokyo), and M. Newman. In manuscript.

(17) An inclusion theorem for modular subgroups. M. Newman. Submitted to a technical journal.

(18) A table of the coefficients of the powers of $\eta(\tau)$. M. Newman. To appear in the Proceedings of the Royal Netherlands Academy of Sciences.

(19) On the existence of identities for the coefficients of certain modular forms. M. Newman. To appear in Journal of the London Mathematical Society.

(20) An alternative proof of a theorem on unimodular groups. M. Newman. Proc. Amer. Math. Soc. 6, 998–1000 (1955).

(21) Integral boundary points of convex polyhedra. A. J. Hoffman and J. B. Kruskal (Princeton University). To appear in the Annals of Mathematics Study 38.

(22) Linear programming. A. J. Hoffman. To appear in Applied Mechanics Reviews.

(23) Systems of inequalities involving convex functions. Ky Fan (University Notre Dame), I. Glicksberg (RAND Corporation), and A. J. Hoffman. In manuscript.

(24) Generalization of a theorem of König. A. J. Hoffman. In manuscript.

ANALYTIC STUDY OF WAR GAMES
Task 1101-10-5116/55-83

Origin and Sponsor: Armament Branch, ARDC, USAF   Authorized 12/29/54
Manager: H. A. Antosiewicz
Full task description: Oct–Dec 1954 issue, p. 7

    Status: INACTIVE.

STUDY OF DIFFERENTIAL EQUATIONS FOR NERVE EXCITATION
Task 1101-10-5116/56-148

Origin and Sponsor: National Institutes of Health   Authorized 9/30/55
                     Bethesda, Md.
Manager: H. A. Antosiewicz
Full task description: July–Sept 1955 issue, p. 7

   Status: CONTINUED. A new method has been adopted for the determination
of the values of the parameter K for which the solutions of the basic system
of differential equations have a prescribed behavior. The previously used
method was based on an approximation to the positive eigenvalue, and its
corresponding eigenvector, of the 5x5 matrix which represents the linear
part of the system of differential equations. Now, this positive eigenvalue
and its eigenvector are computed for each value of the parameter K, and the
initial conditions determining the particular solution are then chosen
for the eigenvector. The change in the computation was felt necessary
because the bounds for the derived values of K found by the old procedure
were so close that further approximations might have yielded spurious
results.
   About 30 cases, both for temperatures 6.3°C and 18.5°C, were
run during this quarter and were submitted to the sponsor.

2. MATHEMATICAL TABLES AND PROGRAMMING RESEARCH

TABLES OF $E_1(z)$, $(z=x+iy)$
Task 1102-40-1110/43-3

Manager: I. Stegun
Full task description: Apr–June 1949 issue, p. 41

Authorized 7/1/47

     Status: CONTINUED. The introduction to the tables has been prepared and checking is in progress.

TABLES OF COULOMB WAVE FUNCTIONS
Task 1102-40-1110/47-2

Origin: NBS
Manager: M. Abramowitz
Full task description: Apr–June 1949 issue, p. 45

Authorized 7/1/47

     Status: CONTINUED. The code is being revised to carry out computations of the functions for a range of values of ρ corresponding to given η and L.

TABLES OF POWER POINTS OF ANALYSIS OF VARIANCE TESTS
Task 1102-40-1110/51-8

Origin: Section 11.3, NBS
Manager: S. Peavy
Full task description: Apr–June 1951 issue, p. 49

Authorized 3/26/51

     Status: INACTIVE. For status to date, see Oct–Dec 1955 issue, p. 8.

REVISION OF MATHEMATICAL TABLES
Task 1102-40-1110/52-7

Origin: NBS
Managers: W. F. Cahill, I. Stegun
Full task description: July–Sept 1951 issue, p. 41

Authorized 8/10/51

     Status: CONTINUED. Revision of "Tables of natural logarithms," vol. IV, Mathematical Table MT12 (1941), for reissue in the Applied Mathematics Series was completed, and the manuscript is ready for submittal for publication.

TABLE OF ARCSIN FOR COMPLEX ARGUMENTS
Task 1102-40-1110/52-14

Origin: NBS   Authorized 10/1/51
Manager: B. Urban
Full task description: July-Sept 1951 issue, p. 41

Status: TERMINATED. It was decided to discontinue preparation of the table for publication because a more comprehensive table of the function was recently published elsewhere.

TABLE OF THE MODIFIED AIRY INTEGRAL
Task 1102-40-1110/52-23

Origin: NBS   Authorized 10/4/51
Manager: I. Stegun
Full task description: July-Sept 1951 issue, p. 42

Status: CONTINUED. Checking of the completed manuscript is in progress.

TABLE OF ERROR FUNCTION FOR COMPLEX ARGUMENTS
Task 1102-40-1110/52-25

Origin: NBS   Authorized 10/5/51
Manager: W. Hall
Full task description: July-Sept 1951 issue, p. 42

Status: INACTIVE. For status to date, see Oct-Dec 1954 issue, p. 11.

SPHEROIDAL WAVE FUNCTIONS
Task 1102-40-1110/52-37

Origin: NBS   Authorized 11/28/51
Manager: D. Liepman
Full task description: Oct-Dec 1951 issue, p. 38

Status: INACTIVE.

SIEVERT'S INTEGRAL
Task 1102-40-1110/52-57

Origin: NBS   Authorized 2/12/52
Managers: M. Paulsen, P. O'Hara
Full task description: Jan-Mar 1952 issue, p. 46

Status: CONTINUED. Checking of the tabular values and preparation of the introductory material continued.

L-SHELL CONVERSION COEFFICIENTS
Task 1102-40-1110/53-52

Origin: Oak Ridge National Laboratory   Authorized 5/20/53
Manager: W. Hall
Full task Description: Apr-June 1953 issue, p. 45

        Status: CONTINUED. Computations for the L_{III} shell were completed
for z = 65 for all values of k; for z = 95, k = .05, 0.1; and for the
L_I shell for z = 55, k = .05.

AUTOMATIC CODING
Task 3711-60-0009/55-65

Origin: NBS   Authorized 9/29/54
Manager: J. Wegstein
Full task description: July-Sept 1954 issue, p. 11

        Status: CONTINUED. A new Base code, BASE 11, has been completed.
It is intended to be used specifically for small problems involving
integrals. In it the 1-, 2- and A-orders of Base 00 are replaced by two-
word "integrate" orders completely specifying an integration of the form
$\int_a^b f(x)dx$ except for the coding of f(x). (See July-Sept 1955 issue, p. 13.)
        By the use of the three integration orders general expressions
of the form $\int\int\int f(x,y,z)dxdydz$ can be coded using only two words to
specify each integration and the coding necessary to compute the various
functions. The integration rule is Gaussian quadrature, and 2-,4-,8-,
and 16-point rules for any interval may be specified.
        Base 11 should be useful in coding small problems quickly where
the behavior of the functions involved is well known and only one integration
is involved or separation of variables cannot be effected. It may also
be used for larger problems provided the necessary numerical analysis is
carried out.
        In addition to the integration routines, Base 11 also contains
all of the service routines and subroutines of Base 01 (see Oct-Dec 1955
issue, p. 10.)
        Work was begun on the BUIC system for SEAC. It is a generating
routine which accepts problems stated in a notation written directly from
the flow diagram of the problem. Algebraic expressions are accepted
directly by the computer in the same form that they can be understood by
any mathematician. Complete logical details have been worked out for the
algebra encoder portion of this system. The feasibility of building a
computer which will operate at high speed directly on algebraic and flow
chart symbols is also being studied.

MATHEMATICAL SUBROUTINES
Task 3711-60-0009/56-160

Origin: NBS   Authorized 9/30/55
Managers: Staff
Full task description: July-Sept 1955 issue, p. 13

        Status: CONTINUED. The development of a base code for matrices
which may be used in problems requiring several types of operations on small

matrices was started. The code will be similar to the Base OO and will use most of the Base OO operations. It will contain subroutines to add and multiply matrices, to compute the value of determinants, to orthonormalize a set of vectors, and to compute the inverse of a given matrix. The elements of the matrices will be expressed in floating binary point form. During this quarter, the addition, multiplication, and determinant evaluation subroutines were written and code checking of these routines was started.

3. PROBABILITY AND MATHEMATICAL STATISTICS

BIBLIOGRAPHY AND GUIDE TO STATISTICAL LITERATURE
Task 1103-10-1107/49-1a

Origin: NBS   Authorized 1/9/49
Manager: L. S. Deming
Full task description: Apr-June 1949 issue, p. 75

Status: CONTINUED. For a description of the continuing activity
on this task, see the Jan-Mar 1954 issue, p. 49.

MANUAL ON FITTING STRAIGHT LINES
Task 1103-10-1107/50-2

Origin: NBS   Authorized 3/1/50
Manager: F. S. Acton
Full task description: Jan-Mar 1950 issue, p. 42

Status: COMPLETED. The manual on the fitting of straight lines has
been completed and is being edited for publication by a commercial house.
Some material from it is being abstracted for use by the ASTM in their
handbook on the "Presentation of Data." The straight line manual is
divided into ten chapters whose titles are:

       Chapter I   - General introduction
              II   - X - Without error - Classical ideas
              III - Several values of y for each x
              IV   - Bivariate normal population
              V   - Both variates in error
              VI   - Several lines - The analysis of variance
              VII - Orthogonal polynomials - Curvature
              VIII - Transformations
              IX   - Rejection of data
              X   - Cumulative data

TABLES TO FACILITATE DRAWING RANDOM SAMPLES
Task 1103-10-1107/51-1

Origin: NBS   Authorized 7/1/50
Managers: C. Eisenhart, L. S. Deming
Full task description: July-Sept 1950 issue, p. 57

Status: INACTIVE. For status to date, see July-Sept 1952 issue,
p. 64.

MISCELLANEOUS STUDIES IN PROBABILITY AND STATISTICS
Task 1103-10-1107/51-2

Origin: NBS   Authorized 7/1/50
Manager: C. Eisenhart
Full task description: July-Sept 1950 issue, p. 58

Status: CONTINUED. For a description of the continuing activity
on this task, see the Oct-Dec issue, p. 12.

Publications:
(1) Chaînes de Markof dans les ensembles abstraits et applications aux
    processus avec régions absorbantes et au problème des boucles. (Formerly,
    "Time-discrete stochastic processes in arbitrary sets, with applications
    to processes with absorbing regions and to the problem of loops in
    Markoff chains.") D. van Dantzig. Annales de l'Institut Henri Poincaré
    14, 145-199 (1955).
(2) A note on the normal distribution. S. Geisser. To appear in the Annals
    of Mathematical Statistics.
(3) A comparison between the mean successive differences and the root mean
    square successive difference. S. Geisser. Withdrawn from publication.
(4) Inequalities for probabilities associated with the multivariate normal
    distribution. I. R. Savage. Withdrawn from publication.

STUDIES IN THE MATHEMATICS OF EXPERIMENT DESIGN
Task 1103-10-1107/53-1

Origin: NBS   Authorized 10/15/52
Manager: W. S. Connor
Full task description: Oct-Dec 1952 issue, p. 60

Status: CONTINUED. R. C. Burton has written a note on "Some
existence theorems for dualized designs."

Publications:
(1) Partially replicated Latin squares. W. J. Youden and J. S. Hunter
    (American Cyanamid Co.) Biometrics 11, 399-405 (Dec. 1955).
(2) Contributions on partially balanced incomplete block designs with
    two associate classes. W. H. Clatworthy. To appear as NBS Applied
    Mathematics Series 47.
(3) Exact tests of significance for combining inter- and intra-block
    information. M. Zelen. Submitted to a technical journal.
(4) On the analysis of covariance. M. Zelen. Submitted to a technical
    journal.
(5) Fractional factorial experiment designs for factors at two levels.
    To appear as NBS Applied Mathematics Series 48.
(6) Design of experiments in research and development. W. J. Youden.
    To appear in Proceedings of the 1955 Conference on the Design of
    Experiments in Army Research, Development, and Testing.
(7) Some examples of the use of high speed computers in statistics.
    J. M. Cameron. To appear in Proceedings of the 1955 Conference on the
    Design of Experiments in Army Research, Development, and Testing.
(8) The principle of randomization in the design of experiments. C. Eisenhart.
    To appear in Proceedings of the 1955 Conference on the Design of
    Experiments in Army Research, Development, and Testing.

RESEARCH ON MATHEMATICAL ASPECTS OF ORDER
STATISTICS METHODS
Task 1103-10-1107/55-110

Origin: NBS   Authorized 3/3/55
Manager: J. Lieblein
Full task description: Jan-Mar 1955 issue, p. 31

     Status: CONTINUED. J. Lieblein consulted with E. L. Brancato and
W. F. Gauster of the Naval Research Laboratory on the application of
extreme-value theory to data on breakdown voltage of transformer oil.
     Dr. Lieblein also corresponded, among others, with N. T. Uzgoren
(University of Istanbul, Turkey) on theoretical aspects of the asymptotic
development of the distribution of extreme values, and with E. Gassner
(Darmstadt, Germany) on the fit of a formula used in fatigue-life testing
of ball bearings.
     The final report (see Jan-Mar 1955 issue, p. 33) to Subcommittee
7 (Load Ratings) of the American Standards Association Committee B-3 (Ball
and Roller Bearings), on "Statistical investigations of the fatigue life of
deep groove ball bearings" has been developed into an article for submittal
to a technical journal.

     Publication:
(1) Application of extreme value theory to cobbles and boulders in gravel
    deposits. W. C. Krumbein (Northwestern University) and J. Lieblein.
    Submitted to a technical journal.

STUDY OF NON-PARAMETRIC STATISTICAL TECHNIQUES
Task 1103-10-1107/56-170

Origin: NBS   Authorized 12/15/55
Manager: Joan R. Rosenblatt
Full task description: Oct-Dec 1955 issue, p. 14

     Status: CONTINUED. A paper is being prepared on the power of some
rank order two-sample tests.
     A talk on the efficiency of statistical tests was given at a
Statistical Engineering Laboratory Seminar on February 17.
     Work was continued on the distribution of Burrow's statistic.

     Publications:
(1) Easily used simultaneous confidence limits for a line. W. S. Connor.
    Submitted to a technical journal.
(2) Contributions to the theory of rank order statistics--two-sample case.
    I. R. Savage. To appear in the Annals of Mathematical Statistics.
(3) Simultaneous tests of randomness and other hypotheses. I. R. Savage.
    To appear in the Journal of the American Statistical Association,
    under the title "On the independence of tests of randomness and other
    hypotheses."

MEASUREMENT OF RELIABILITY
Task 1103-10-1130/56-182

Origin: NBS   Authorized: 3/23/56
Manager: M. Zelen

Objective: To conduct research on the mathematical and statistical aspects of the definition, measurement, and specification of the reliability of components and assemblies, with particular attention to the evaluation of the reliability of electronic components and systems.

Background: The improvement of the reliability of electronic equipment, civilian as well as military, is one of the major problems of science and technology today. It is highly desirable that electronic computers and communications equipment operate with satisfactory reliability over relatively long periods of continuous or intermittent use. On the other hand, electronic systems of guided missiles, for example, are required to withstand a long "shelf-life" yet perform with high reliability during their very brief period of use. While it is widely recognized that reliability is primarily a probability problem, and that the measurement of reliability is largely a statistical problem, only a beginning has been made in applying recent developments in statistical inference, experiment design, and statistical analysis, to the definition and measurement of the reliability of complex assemblies.

Status: NEW. Examples of the literature on measurement and prediction of reliability are being collected and reviewed.
        Work is being done on methods for obtaining confidence limits for the product of binomial parameters.

4. MATHEMATICAL PHYSICS

RESEARCH IN MATHEMATICAL PHYSICS AND RELATED FIELDS
Task 1104-10-1115/55-57

Origin: NBS   Authorized 9/1/54
Manager: R. F. Dressler
Full task description: July-Sept 1954 issue, p. 27

Status: CONTINUED. New methods have been developed by P. Henrici to speed up the convergence of the Quotient-Difference Algorithm and to apply it to the numerical determination of the residues of a meromorphic function. Also some applications were made of I. N. Vekva's theory of elliptic differential equations with analytic coefficients. Several representations for the complex Riemann function of the equation

$$\Delta u + \frac{\nu}{y} \frac{\partial u}{\partial y} + k^2 u = 0,$$

have been obtained.

As a continuation of previous work on addition theorems P. Henrici has obtained several new addition theorems for Lommel functions. These are of importance in the solution of the inhomogeneous wave equation.

Publications:
(1) Comparison of theories and experiments for the hydraulic dam-break wave. R. F. Dressler. Publication No. 38 de l'Association Internationale d'Hydrologie (Assemblee generale de Rome, 1954, tome III, p. 319-328). Extrait.
(2) Entropy changes in rarefaction waves. R. F. Dressler. Submitted to a technical journal.
(3) A discussion of the paper, "Design of corrugated diaphragms," by J. A. Haringx. R. F. Dressler. To appear in the Transactions of the American Society of Mechanical Engineers.
(4) On generating functions for the Jacobi polynomials. P. Henrici. Pac. J. Math. 5, 923-931 (1955).
(5) On the representation of a certain integral involving Bessel functions of hypergeometric series. P. Henrici. Submitted to a technical journal.
(6) On the domain of regularity of generalized axially symmetric potentials. P. Henrici. To appear in the Proceedings of the American Mathematical Society.
(7) The quotient-difference algorithm. P. Henrici. In manuscript.

RESEARCH IN ELECTROMAGNETIC THEORY
Task 1104-10-5160/54-47

Origin and Sponsor: Diamond Ordnance Fuze Laboratory,   Authorized 6/29/54
                    Department of the Army   Revised   9/29/54
Manager: F. Oberhettinger
Full task description: July-Sept 1954 issue, p. 28

Status: INACTIVE.

RESEARCH IN MATHEMATICAL ELASTICITY
Task 1104-10-5160/55-85

Origin: NBS   Authorized 12/27/54
Sponsor: Office of Scientific Research, ARDC, USAF
Manager: R. F. Dressler
Full task description: Oct-Dec 1954 issue, p. 30

Status: CONTINUED. The second phase of the corrugated diaphragm
project is being continued,--to analyze a sequence of diaphragms with a
fixed shape for a range of different thicknesses in order to determine the
relative importance of bending and stretching effects. The problem
originally solved by R. F. Dressler and W. Cahill was for a thickness
h = .007 inches. Now the case 3h has been completely solved also and
exhibits the following interesting property: For average thicknesses,
all stresses causing stretching vary with the same frequency as the corrugation
profile shape, whereas all bending stresses vary with a double frequency.
However, for the thick diaphragm the present results indicate that the
double frequency behavior almost disappears for all bending stresses. The
next case, now being analyzed, corresponds to h/3. For this problem all
four homogeneous solutions were computed, but the general solution is not
yet completed.

On the vibrating triangular wing project, I. Rhodes and U. Hochstrasser
satisfactorily rectified the difficulty in the code for obtaining higher
eigenvalues and eigenvectors for the basic 78x78 asymmetric matrices.
On small test matrices the second eigenvalues were obtained with high
accuracy; this code is to be applied to the large matrices describing the
wing problem.

J. L. Synge worked on a geometrical approach to problems of
forced vibrations in elasticity, the solution appearing as the intersection
of two orthogonal linear subspaces in a suitable function space. This
approach led to methods of approximate solution. A paper on this work is
to be presented at the Eighth Symposium on Applied Mathematics, Chicago,
April 12-13.

J. L. Synge has applied tensor methods to the study of the
general theory of linear elastic waves in completely anisotropic media,
developing a theory of Rayleigh surface waves in such media. A report on
this investigation was prepared.

J. L. Synge and W. Cahill engaged on an approximate numerical
solution on SEAC of the elastic torsion problem for the hollow square.
The solution uses the Prager-Synge hypercircle method, which gives upper
and lower bounds for the torsional rigidity. Final calculations on the SEAC
for this problem are in progress.

Publications:
(1) Investigations of the properties of corrugated diaphragms. W. A. Wildhack
    (NBS OBI), R. F. Dressler, and E. C. Lloyd (NBS Mechanics Division).
    To appear in the Transactions of the American Society of Mechanical
    Engineers. (Now available as ASME Preprint No. 55-A-181.)
(2) Stationary principles for forced vibrations in elasticity and electro-
    magnetism. J. L. Synge. Submitted to a technical journal.
(3) Elastic waves in anisotropic media. J. L. Synge. In manuscript.

FOURIER TRANSFORMS OF PROBABILITY DISTRIBUTION FUNCTIONS
Task 1104-10-5160/56-154

Origin: NBS   Authorized 9/30/55
Sponsor: Office of Naval Research
Managers: F. Oberhettinger, J. Lieblein
Full task description: July-Sept 1955 issue, p. 20

        Status: CONTINUED. Further examples have been added to the
collection of Fourier transforms of distribution functions. This completes
the present compilation, which contains some previously underived results.
The whole material is in systematic form ready for book publication when
the accompanying text is written.

RESEARCH IN FLUID DYNAMICS OF TWO-PHASE FLOWS
Task 1104-10-5160/56-155

Origin: Office of Naval Research   Authorized 9/30/55
Sponsor: "   "
Manager: R. F. Dressler
Full task description: July-Sept 1955 issue, p. 21

        Status: CONTINUED. Relations between the states on both sides of
an interface separating two phases of a moving fluid have been determined
for the cases in which the phase transition is brought about by heat
removal and/or cold liquid addition at the interface. If the specific
volume of the liquid state is neglected in comparison with the specific
volume of the vapor state and the enthalpy of the liquid state is given
as a linear function of the temperature alone, then an explicit solution
has been found for the liquid state variables in terms of the other parameters.
For more accurate results, a rapidly converging iterative scheme has been
developed which utilizes directly thermodynamic tables of the vapor and
liquid. Some calculations have been made for the specific case of a steam-
water interface. For a stationary interface and fixed thermodynamic state
of the vapor, upper and lower bounds for heat removal or mass addition
rates have been found as a function of the incoming steam velocity. Conversely,
for given heat removal or mass addition, bounds have been obtained for the
steam velocity. A paper on this first aspect of the investigation has been
prepared.

        Publication:
(1) Condensation interfaces in two-phase flow. P. Chiarulli and R. F. Dressler.
    In manuscript.

RESEARCH IN MATHEMATICAL GEOPHYSICS
Task 1104-10-5160/56-156

Origin: The American University   Authorized 9/30/55
Sponsor: Office of Naval Research
Manager: R. Stoneley
Full task description: July-Sept 1955 issue, p. 21

        Status: CONTINUED. The investigation of the variation of amplitude
with depth for Rayleigh waves in a continent with a double surface layer
has been completed by R. Stoneley and U. Hochstrasser. The results show
that a nodal point for the amplitude may exist in either of the two surface

layers depending upon the relative sizes of the various parameters. This
work was presented at the meeting of the Seismological Society of America,
Reno, Nevada, March 30-31.

A paper dealing with the hydrodynamical aspects of turbidity
currents in oceans was also completed by R. Stoneley.

The problem of the propagation of Rayleigh waves across an ocean
floor in which there are two rocky layers has been programmed by U. Hochstrasser
for computation by the SEAC.

Four lectures by R. Stoneley presented at an NBS seminar on the
general theory of elastic surface waves have been written up as notes by
P. Henrici. This will also be incorporated in a Monograph on elastic waves
which is now in preparation.

    Publications:
(1) The transmission of Rayleigh waves across an ocean floor with two surface
    layers. Part I. R. Stoneley. To appear in the Bulletin of the
    Seismological Society of America.
(2) On the propagation of turbidity currents. R. Stoneley. To appear in
    the Vening Meinesz Jubilee Volume.
(3) Lectures on elastic surface waves. R. Stoneley. In manuscript.

RESEARCH IN RADIATION THEORY
Task 1104-10-5160/56-175

Origin: NBS   Authorized 12/28/55
Sponsor: Office of Naval Research
Manager: F. Oberhettinger
Full task description: Oct-Dec 1955 issue, p. 18

    Status: CONTINUED. Investigations concerning the asymptotic
behavior of certain integrals describing the far zone field of electromagnetic
waves diffracted by a wedge are continuing. The case of an incident plane
wave field (see J. Math. Phys. $\underline{34}$, 1956) is being extended to take care
of an incident cylindrical and spherical wave field. This involves reduction
of integrals of the form

$$I(\delta,\alpha) = -\frac{1}{2\alpha} \sin(\pi\delta/\alpha) \int_0^\infty \frac{H(x)\,dx}{\cosh(\pi x/\alpha) - \cos(\pi\delta/\alpha)}$$

with

$$H(x) = \begin{cases} H_0^{(2)}[k(\rho^2+\rho'^2+2\rho\rho'\cosh x)^{\frac{1}{2}}] \\ \\ \text{or} \\ \\ \dfrac{\exp(-ik[\rho^2+\rho'^2+(z-z')^2+2\rho\rho'\cosh x]^{\frac{1}{2}})}{\rho^2+\rho'^2+(z-z')^2+2\rho\rho'\cosh x]^{\frac{1}{2}}} \end{cases}$$

into an asymptotic series for large ρ.

5. MATHEMATICAL AND COMPUTATIONAL SERVICES

1102-40-5126/50-13   RAY TRACING
Origin and Sponsor: NBS, Section 2.2
Manager: E. Haynsworth, P. Walsh
Full task description: Jan-Mar 1950 issue, p. 33
Status: Continued. It was found necessary to compute the inverse of a
   given matrix ($n \leq 28$) which was stored in fixed binary point form. A
   code was written in two parts: (1) To read in the matrix and convert it
   to floating binary point form. A previously written code for computation
   of the inverse in floating binary point form was then used. (2) To
   convert the inverse of the matrix from floating binary point form, and to
   transfer the matrix to wire by rows. The two sections of the code are
   being checked out.

1102-40-5126/51-37   MOLECULAR STRUCTURE, III
Origin and Sponsor: Naval Research Laboratory, USN
Manager: P. O'Hara
Full task description: July-Sept 1951 issue, p. 50
Status: Continued. Additional analyses were performed to determine the
   structures of the spurite and dimethoxybenzophenone crystals.

1102-40-5126/52-44   CALCULATIONS FOR d SPACINGS
Origin and Sponsor: NBS, Division 9
Full task description: Oct-Dec 1951 issue, p. 47
Manager: R. Zucker
Status: Continued. Calculations for d-spacings were performed for 3
   tetragonal, 9 hexagonal and 20 orthorhombic crystals. Also determination
   of unit cell constants was carried out by least squares fitting to
   measured d-spacings for 7 tetragonal, 6 hexagonal, and 23 orthorhombic
   crystals.

1102-40-5126/53-27   COMPUTATION OF THERMODYNAMIC FUNCTIONS
Origin and Sponsor: NBS, Section 3.2
Manager: E. Marden
Full task description: Jan-Mar 1953 issue, p. 57
Status: Continued. Thermodynamic functions were re-computed for zinc ($Z_n T$),
   making use of revised input constants. Under another code thermodynamic
   functions were computed for trans-difluorodichloroethylene.

1102-40-5126/53-51   RADIATION DIFFUSION
Origin: NBS, Section 4.8
Sponsor: Atomic Energy Commission
Manager: J. Doggett (4.8)
Full task description: Apr-June 1953 issue, p. 57 (Neutron Diffusion III)
Status: Continued. The data obtained from the Mott formula code for the
   elastic scattering of electrons and positrons by nuclei have been checked
   by interpolation schemes and reruns. A manuscript on the results has been

submitted to a technical journal.
      The basic codes for the generation of collision density patterns
of gamma radiation by Monte Carlo methods have been revised. Preliminary
runs indicate an increase by a factor of two in the operational efficiency
of the code.

1102-40-5126/54-13   AWARD OF PROCUREMENT CONTRACTS BY LINEAR PROGRAMMING
Origin and Sponsor: New York Quartermaster Procurement Agency
Manager: H. Bremer
Full task description: Oct-Dec 1953 issue, p. 43
Status: Continued. Analysis of contract award problems continued to be
  processed on SEAC as they were submitted by the sponsor. During this
  quarter, the awards for approximately 15 contracts were determined.

3711-60-0009/54-17   DEPOLYMERIZATION
Origin: NBS, Section 7.6
Manager: U. Hochstrasser
Full task description: Oct-Dec 1953 issue, p. 44
Status: Continued. Some additional cases were run with new values of the
  parameters σ and ε as needed in further investigations under way by
  the originator.

3711-60-0009/54-22   ENERGY DISTRIBUTIONS ON OPTICAL IMAGE
Origin: NBS, Section 2.2
Manager: L. S. Joel
Full task description: Jan-Mar 1954 issue, p. 43
Status: Continued. The new code was verified as correct for $W = \arctan (y/x)$,
  $W = 9x(x^2 + y^2)$.

3711-60-0009/54-30   SPECTRUM ANALYSIS
Origin: NBS, Division 4
Manager: S. Prusch
Full task description: Jan-Mar 1954 issue, p. 46
Status: Continued. Searching for pairs of lines for approximately 14 common
  differences was carried out for Ruthenium I.

3711-60-0009/54-38   COMPRESSIBILITY FACTORS OF DRY AIR
Origin: NBS, Section 3.2
Manager: M. Paulsen
Full task description: Jan-Mar 1954 issue, p. 48
Status: Inactive. For status to date, see Apr-June 1955 issue, p. 12.

1102-40-5126/55-39   MOLECULAR VIBRATIONS
Origin and Sponsor: NBS, Section 3.2
Manager: K. Goldberg
Full task description: July-Sept 1954 issue, p. 16
Status: Inactive.

1102-40-5126/54-43   CHARACTERISTICS OF CONDUCTING RESISTORS
Origin and Sponsor: NBS, Section 1.6
Manager: B. G. Urban
Full task description: Apr-June 1954 issue, p. 40
Status: Inactive. For status to date, see Apr-June 1955 issue, p. 12.

3711-60-0009/55-53   ELECTRONIC FUNCTIONS
Origin: NBS, Section 4.5
Manager: W. G. Hall
Full task description: Apr-June 1955 issue, p. 12
Status: Continued. The tabular material was typed, and the final readying
  of the manuscript for publication was almost completed.

1102-40-5126/55-58   ELECTROMAGNETIC RADIATION FROM LIGHTNING
Origin and Sponsor: NBS, Section 82.1
Manager: B. G. Urban
Full task description: Jan-Mar 1955 issue, p. 17
Status: Inactive. For status to date, see Jan-Mar 1955 issue, p. 17.

1102-40-5126/55-61   ELASTIC CROSS SECTION FOR NEUTRON SCATTERING
Origin and Sponsor: Naval Research Laboratory
Manager: I. Stegun
Full task description: Oct-Dec 1954 issue, p. 18
Status: Inactive. For status to date, see Apr-June 1955 issue, p. 13.

3711-60-0009/55-66   RECONSTITUTION OF MONOCHROMATIC LIGHT INTENSITIES
Origin: NBS, Division 30
Manager: H. Bremer
Full task description: July-Sept 1954 issue, p. 18
Status: Inactive. For status to date, see Oct-Dec 1954 issue, p. 19.

3711-60-0009/55-68   CRYSTAL STRUCTURE CALCULATIONS
Origin: NBS, Division 9
Manager: R. Prosen
Full task description: Jan-Mar 1955 issue, p. 18
Status: Continued. A general program applicable to all crystallographic
  space groups is being written that will calculate least squares refinements
  for atomic positions as well as individual anisotropic temperature factor
  parameters for each atom. Code-checking of the general structure factor
  routine is progressing satisfactorily. The code for the general Fourier
  routine to calculate three-dimensional electron density maps has been
  punched and is ready for checking.

1102-40-5126/55-74   LIQUID-VAPOR TRANSITION, II
Origin and Sponsor: Naval Medical Research Institute
Manager: S. Prusch
Full task description: Jan-Mar 1955 issue, p. 19
Status: Inactive.

3711-60-0009/55-75   PARAMETER OF THE DISPERSION EQUATION FOR OPTICAL GLASS
Origin: NBS, Section 2.2
Manager: R. Zucker
Full task description: Jan-Mar 1955 issue, p. 20
Status: Continued. For a given set of observed wavelength λ, and index of
  refraction n, the constant of dispersion k_i was determined by the method of
  least squares, using the original code. A new code was written and checked
  to set up a table of the computed values of n_c,

$$n_c = 1 + \sum_{i=1}^{5} \frac{k_i^2}{\lambda^2 - \lambda_i^2}$$

The table of n_c was prepared for λ = .54(.02)2(.2)20(.1)40 for given values
  of λ_i^2 and k_i.

1102-40-5126/55-81   COMBINING TESTS FOR SIGNIFICANCE
<u>Origin</u>: NBS, Section 11.3
<u>Manager</u>: L. S. Joel
<u>Full task description</u>: Oct-Dec 1954 issue, p. 23
<u>Status</u>: Continued. The bulk of the results for the table have been
   transmitted to the sponsor. It remains to compute and check scattered
   values.

3711-60-0009/55-82   THERMOMETER CALIBRATIONS
<u>Origin</u>: NBS, Section 3.1
<u>Manager</u>: S. Prusch
<u>Full task description</u>: Jan-Mar 1955 issue, p. 20
<u>Status</u>: Continued. Calibration tables were run on approximately 49
   thermometers under test.

1102-40-5126/55-88   STRESSES IN A WALL FOUNDATION
<u>Origin and Sponsor</u>: NBS, Section 10.1
<u>Managers</u>: E. Marden, G. Hawkins
<u>Full task description</u>: Jan-Mar 1955 issue, p. 22
<u>Status</u>: Inactive.

1102-40-5126/55-103 MISSOURI RIVER PROBLEM
<u>Origin and Sponsor</u>: Missouri River Division, Corps of Engineers, U.S. Army
<u>Manager</u>: H. Bremer
<u>Full task description</u>: Jan-Mar 1955 issue, p. 26
<u>Status</u>: Continued. New data from the sponsor was processed on UNIVAC using
   codes already set up.

1102-40-5126/55-105 AERONOMIC TIDAL WINDS OF THERMAL ORIGIN
<u>Origin and Sponsor</u>: NBS, Section 82.1
<u>Managers</u>: B. G. Urban, H. H. Howe (82.1)
<u>Full task description</u>: Jan-Mar 1955 issue, p. 26
<u>Status</u>: Inactive. For status to date, see Jan-Mar 1955 issue, p. 26.

1102-40-5126/55-113 REACTOR DESIGN
<u>Origin</u>: Westinghouse Atomic Power Division
<u>Sponsor</u>: Atomic Energy Commission
<u>Manager</u>: U. Hochstrasser
<u>Full task description</u>: Jan-Mar 1955 issue, p. 28
<u>Status</u>: Continued. Some changes in the code were made in order to be able
   to iterate on the equations for high and low energy level flux
   separately. A change in the computation of the eigenvalues was prepared.
   Several additional runs with the original code were made in order to
   complete the study of the best choice of an over-relaxation factor.

1102-40-5126/55-117 ATTENUATION OF PRESSURE PULSES OF FINITE AMPLITUDE
<u>Origin</u>: NBS, Section 3.2
<u>Sponsor</u>: Bureau of Aeronautics, U. S. Navy
<u>Manager</u>: M. Paulsen
<u>Full task description</u>: Apr-June 1955 issue, p. 18
<u>Status</u>: Inactive. For status to date, see July-Sept 1955 issue, p. 30.

1102-40-5126/55-118 **THERMOMETER CALIBRATION, II**
<u>Origin and Sponsor</u>: NBS, Section 3.1
<u>Manager</u>: B. G. Urban
<u>Full task description</u>: Apr–June 1955 issue, p. 18
<u>Status</u>: Continued. An additional code to compute certain constants and
   differences formerly computed by hand was completed and checked out.
   Tables for eight thermometers were computed and transmitted to sponsor.
           A supplementary code to edit finished results is being written.

1102-40-5126/55-121 **ELECTRON PENETRATION**
<u>Origin</u>: NBS, Section 4.8
<u>Sponsor</u>: Atomic Energy Commission
<u>Manager</u>: S. Peavy
<u>Full task description</u>: Apr–June 1955 issue, p. 19
<u>Status</u>: Continued. Preparation of the code continued.

1102-40-5126/55-122 **SOLUTION OF NORMAL EQUATIONS**
<u>Origin</u>: Advisory Committee on Weather Control
<u>Sponsor</u>: U. S. Weather Bureau
<u>Manager</u>: M. Newman
<u>Full task description</u>: Apr–June 1955 issue, p. 20
<u>Status</u>: Inactive.

1102-40-5126/55-123 **TEMPERATURE DISTRIBUTION**
<u>Origin</u>: NBS, Section 6.4
<u>Sponsor</u>: NBS, Section 6.4
<u>Manager</u>: W. G. Hall
<u>Full task description</u>: Apr–June 1955 issue, p. 19
<u>Status</u>: Inactive. For status to date, see Oct–Dec 1955 issue, p. 24.

1102-40-5126/55-124 **EVALUATION OF INTEGRALS RELATED TO GAS FLOW**
<u>Origin</u>: NBS, Section 3.2
<u>Sponsor</u>: Bureau of Aeronautics, U. S. Navy
<u>Manager</u>: J. Cooper
<u>Full task description</u>: Apr–June 1955 issue, p. 20
<u>Status</u>: Reactivated. The project was reopened to compute values of
   the integrals R_1 and R_2 for new parameters. In addition, the code was
   modified so that the times taken to fill containers could be computed
   directly. This involved computing the following quantities for each
   value of a, instead of R_1 and R_2.

$$t_1 = a\sqrt{3}\, R_1 + t_c$$

$$t_2 = a\, R_2 + t_c$$

where
$$t_c = 14.022\,[\,(1-x_c)^{-1/7}-1\,]$$

and
$$x_c = a\,[\,\frac{.528(1+.005a)}{1+.528a} - 0.005\,]$$

       Calculations were made for 12 values of a ranging from 0.1130
   to 0.9040 and for $\beta = .533(.05).033, .963, .983$.

1102-40-5126/55-126 AERODYNAMIC HEATING
Origin and Sponsor: Diamond Ordnance Fuze Laboratory, Dept. of the Army
Managers: B. Walter, R. Capuano
Full task description: July-Sept 1955 issue, p. 31
Status: Continued. T_W was calculated with the following modifications:
$B_o h_e \Delta t$ increased by 2°/○ and T_{AW} increased 8°F for each of the four
missile trajectories. The corresponding variations of T_W and of the T_W
intersections were calculated and compared with the modifications
described in the Oct-Dec 1955 issue, p. 24.
        A table of W as a function of L, M, and ΔS was calculated for
each of the four trajectories from the equation,

$$\Delta W = \frac{\frac{M}{L} - W_1}{\frac{1}{L\Delta S} + \frac{1}{2}},$$

where $M = 19.62 \cos [\frac{\theta_1 + \theta_2}{2}]$,

$L = (C_{D_1} + C_{D_2})(\rho_1 + \rho_2) 1.186 \cdot 10^{-3}$,

$\Delta S = V\Delta t$,

and tables of θ, ρ, C_D were given. Based on the computed values of W,
the original velocity was then checked against the velocity obtained
by the relation,

$$\Delta V = \frac{V_1}{2} \frac{\Delta W}{W_1} [1 - \frac{1}{4} \frac{\Delta W}{W_1} + \frac{1}{8}(\frac{\Delta W}{W_1})^2 - \frac{5}{64}(\frac{\Delta W}{W_1})^3 + \ldots],$$

where $W_1 = V_1^2$.
        Then L was increased by 2°/○, which is equivalent to increasing
the ambient density by 2°/○, and the change in V was determined in
accordance with the above equations.
        The values of T_W as a function of time were calculated for the
modified density and velocity conditions in accordance with the procedure
previously outlined (Oct-Dec 1955 issue) for two of the ranges. The
intersections of the two strip temperatures were then compared with those
obtained for the unmodified conditions.

1102-40-5126/55-127 VIBRATIONS OF CIRCULAR DISC
Origin and Sponsor: Evans Signal Laboratory
Manager: U. Hochstrasser
Full task description: July-Sept 1955 issue, p. 32
Status: Continued. A set of solutions for the equations described in
the July-Sept 1955 issue has been obtained. The code has been changed
in order to eliminate the singularities on the lefthand side of the
mentioned equation.

3711-60-0009/56-131 RAY TRACING
Origin: NBS, Section 2.2
Manager: E. Marden
Full task description: July-Sept 1955 issue, p. 33
Status: Continued. Code checking is in progress.

1102-40-5126/56-133   COMPLEX EIGENVALUES
Origin: Moore School of Engineering
Sponsor: Office of Naval Research
Manager: I. Stegun
Full task description: July-Sept 1955 issue, p. 33.
Status: Continued. The largest eigenvalues for two matrices of order ten
  were obtained, together with the successive vectors.

1102-40-5126/56-134   TRANSMISSION-DELAY TIMES
Origin: NBS, Section 82.1
Sponsor: NBS, Section 82.1
Managers: B. G. Urban, H. H. Howe (82.1)
Full task description: July-Sept 1955 issue, p. 34
Status: Continued. The bulk of the tables have been computed.

1102-40-5126/56-136   CALCULATION OF WAVE FUNCTIONS BY HARTREE METHOD
Origin: Naval Research Laboratory
Sponsor: "   "   "
Manager: S. Peavy
Full task description: July-Sept 1955 issue, p. 34
Status: Continued. The new code was checked out, and the results were
  transmitted to the sponsor. The simplification of the equations reduced
  the SEAC time considerably. This made it possible to carry out the
  computation for certain cases to many iterations.

1102-40-5126/56-137   STABILITY OF SUPPORTED PLATES
Origin and Sponsor: National Advisory Committee on Aeronautics
Manager: R. Zucker
Full task description: July-Sept 1955 issue, p. 35
Status: Continued. Computations were continued for r=3 and r=2 for various
  combinations of k_c, k_s, and β. The calculations are now extended for
  negative values of k_c and k_s. As answers are obtained, they are submitted
  to the sponsor.

1102-40-5126/56-139   STUDY OF INTERNUCLEAR POTENTIAL FOR H_3
Origin and Sponsor: NBS, Section 3.2
Manager: E. Haynsworth
Full task description: July-Sept 1955 issue, p. 36
Status: Inactive. For status to date, see Oct-Dec 1955 issue, p. 26.

1102-40-5126/56-140   MULTIPLE CORRELATION ROUTINES
Origin and Sponsor: Agricultural Economics Division, Department of
                      Agriculture
Managers: H. Bremer, M. Paulsen
Full task description: Oct-Dec 1955 issue, p. 26
Status: Continued. A program has been set up for the sponsor to do the
  the computations on SEAC for least squares regression problems and
  the evaluation of correlation coefficients. This program consists of
  three basic routines.
        For each regression problem the variables may or may not undergo
  any of the following transformations,--logarithm of original variables,
  the first difference of the variable or its logarithm. Using these
  transformed variables the moment matrix is then computed. This part of
  the program is designated as Routine I.
        Routine II consists of existing codes for matrix inversion and

is used to compute the inverse of the moment matrix.
        Routine III takes the inverse matrix and computes the
                a) regression coefficient
                b) standard errors of the partial regression coefficients
                c) partial correlation coefficient
                d) multiple correlation coefficient
                e) standard errors of estimate and the constant for
                   the regression equation.

        So far nine problems have been submitted by the sponsor and were
processed by the above program. Each problem took approximately 20 to
40 minutes depending upon the number of variables and number of observations.
It is hoped that this running time will be reduced by about one third when
the routines are better integrated. Also considerable time will be saved
if a matrix conversion code is written so that the entire problem can be
done in the internal memory.
        It is planned that some additional routines will be written to
aid the sponsor in fitting systems of equations by the limited information
approach.

1102-40-5126/56-143   CHARGED PARTICLE TRAJECTORIES IN THE MAGNETIC FIELD
                    OF THE EARTH
Origin and Sponsor: Naval Research Laboratory
Manager: J. H. Wegstein
Full task description: Oct-Dec 1955 issue, p. 27
Status: Continued. The trajectories for 22 more sets of initial conditions
  were computed with the NORC and were sent to the sponsor.

1102-40-5126/56-147   GROUND WAVE ATTENUATION
Origin and Sponsor: NBS, Section 82.1
Managers: B. G. Urban, H. H. Howe (82.1)
Full task description: Oct-Dec 1955 issue, p. 29
Status: Inactive. For status to date, see Oct-Dec 1955 issue, p. 30.

1102-10-5126/56-151   MULTIPLE SCATTERING IN CROSS SECTION MEASUREMENTS
Origin and Sponsor: Naval Research Laboratory
Manager: I. Rhodes
Full task description: Oct-Dec 1955 issue, p. 30
Status: Continued. Of the 16 sets of parameters, assigned computations on
  four have been completed. Computing time takes from 25 to 40 minutes,
  depending on the number of trials required.

1102-40-5126/56-152   COST ACCOUNTING OPERATIONS FOR HIGH SPEED COMPUTERS, II
Origin and Sponsor: Bureau of Supplies and Accounts, Department of the Navy
Manager: G. Hawkins
Full task description: July-Sept 1955 issue, p. 38
Status: Continued. The code for editing and presenting the output was
  finished. Because time on the UNIVAC in the Washington area is
  practically impossible to obtain, a total of only three hours of code
  checking was available during the quarter. Debugging of the codes was
  thus delayed.

1102-40-5126/56-157   DAMAGE ASSESSMENT
Origin and Sponsor: Office of the Assistant Secretary of Defense (Supply
                      and Logistics)
Managers: A. J. Hoffman, H. Bremer
Full task description: Oct-Dec 1955 issue, p. 31
Status: Continued. Meetings have been held with the sponsors in order to

reformulate the model so that new and more extensive programs could be
be written that will more nearly represent the problem. Some of the
input programs are being written at present. There is also an interim
code to be written which will adapt routines of the past to conform with
a better representation of the input data.

1102-40-5126/56-158   FEDERAL RESERVE DATA
Origin and Sponsor: Federal Researve Board
Manager: E. Marden
Full task description: Oct-Dec 1956 issue, p. 31
Status: Continued. Five codes were written, together with some needed
  auxiliary service routines that were unavailable at the UNIVAC installations
  where these tabulations were performed.
        It became increasingly difficult to obtain sufficient UNIVAC time
to accomplish the desired objectives, and even time on auxiliary
machines was in short supply.
        The Air Force card-to-tape machine was used to convert the
information on the approximately 200,000 punched cards to 55 UNIVAC
magnetic tapes, which were then processed (and to some extent compressed)
to form new data tapes for use in the actual tabulations. UNIVAC's
at the Census Bureau, the Army Map Service, and the Du Pont Company (in
Newark, Delaware) were used for this purpose. Tabulations, making use
of the processed data, are under way on the Du Pont UNIVAC.

1102-40-5126/56-162   STRESSES IN A WALL RESTING ON A FOOTING
Origin and Sponsor: NBS, Section 10.1
Manager: I. Stegun
Objective: To evaluate on SEAC coefficients in a stress function $\emptyset$ which
  is used in obtaining the stresses and strains due to shrinkage in a
  concrete wall resting on a footing.
Background: The interior of a wall can be considered to be an elastic
  slab which obeys the equation of elasticity. In the equation

$$\frac{\partial^4 \emptyset}{\partial x^4} + 2 \frac{\partial^4 \emptyset}{\partial x^2 \partial y^2} + \frac{\partial^4 \emptyset}{\partial y^4} = 0, \tag{1}$$

$\emptyset$ is the stress function which gives the stresses in the wall by the
following relationships:

$$\sigma_x = \frac{\partial^2 \emptyset}{\partial y^2} = \text{stress in x-direction,}$$

$$\sigma_y = \frac{\partial^2 \emptyset}{\partial x^2} = \text{stress in y-direction,}$$

$$\tau_{xy} = -\frac{\partial^2 \emptyset}{\partial x \partial y} = \text{shear stress.}$$

No single expression satisfying equation (1) above and the boundary
conditions of the problem could be found. Therefore it has been decided
to obtain a solution in the form of a series of expressions, each of
which will identically satisfy equation (1) and the sum of which can be
made to satisfy the boundary conditions to any desired degree of accuracy.
The equation for the stress function used is

$$\emptyset = \sum_{n=1,3,\ldots} \sum_{n=1,2,\ldots} a_{mn} \sin \frac{m\pi x}{a} \sin \frac{n\pi y}{b},$$

$$\text{w, e}\quad a_{mn}\ (\text{n odd}) = \frac{n k_m + m t_n + (-1)^{\frac{n-1}{2}} p_m}{(m^2 \frac{b}{a} + n^2 \frac{a}{b})^2}$$

$$a_{mn}\ (\text{n even}) = \frac{n \ell_m + m t_n + (-1)^{\frac{n}{2}} n s_m}{(m^2 \frac{b}{a} + n^2 \frac{a}{b})^2}$$

The coefficients k_m, ℓ_m, t_n, p_m, and s are to be determined by the boundary conditions. This necessitates the solution of 40 simultaneous equations for a wall twice as high as it is long, and of 60 simultaneous equations for a square wall. (For the computation of the stress function, see task 1102-40-5126/55-88, Jan-Mar 1955 issue, p. 22.)
Status: New. The solutions have been obtained for the rectangular wall (40 simultaneous equations) and the square wall (60 simultaneous equations). The matrix inversion codes were employed restricting the number of vectors to two--the vector of the unknowns and a check vector.

1102-40-5126/56-163   ANGULAR DISTRIBUTIONS AND POLARIZATION EFFECTS IN
                             NUCLEAR SCATTERING
Origin and Sponsor: Naval Research Laboratory
Manager: I. Stegun
Full task description: Oct-Dec 1955 issue, p. 32
Status: Continued. The code was completed, and various sample problems
  are being run to check approximation formulae.

1102-40-5126/56-165   INTEGRALS FOR SCATTERING FUNCTIONS
Origin and Sponsor: Naval Research Laboratory
Manager: R. Zucker
Full task description: Oct-Dec 1955 issue, p. 32
Status: Continued. For $\xi \gg 1$, the value of

$$I_{LIMIT} = \frac{8\xi}{p^2}\ \frac{1}{[\ln(40^2 \xi)-1]}$$

was verified for several sets of p and ξ. The code was checked out, and a sample case was run for a given set of parameters.

1102-40-5126/56-166   SCF-LCAO SOLUTION OF SOME HYDRIDES
Origin and Sponsor: NBS, Section 5.9
Manager: E. Haynsworth
Objective: To find the eigenvalues, ϵ_i, and eigenvectors, C_i of the
  secular equation

$$(H+G)C = \epsilon SC$$

where H, G, and S are nxn symmetric matrices, $n \leqslant 6$. H and S are constant, but the elements of G are quadratic functions of the eigenvectors C_i.
Background: The eigenvectors are the coefficients of the atomic orbital in the LCAO approximation to a molecular orbital, and the secular equation results from minimization of the expression for the ground state energy for the molecules considered with respect to the coefficients. (See C.C.J. Rootham, Rev. Modern Phys. 23, 69 (1951).) The problem was

requested by Morris Krauss (5.9).

Status: New. The main code has been written but has not been checked as a whole. Most of the subroutines involved, such as matrix multiplication and addition, calculation of determinants, orthonormalization of vectors, have been checked.

1102-40-5126/56-169   CRYSTAL FIELD EFFECTS FOR ATOMS

Origin and Sponsor: NBS, Division 3

Manager: I. Stegun

Objective: To compute eigenvalues and eigenvectors of matrices as functions of parameters describing various crystal fields.

Background: The calculations arise in the study of the effect of the combinations of crystal field and spin-orbit coupling on the optical and magnetic properties of solids. The problem was transmitted by C. M. Herzfeld (3.0).

Status: New. For heavy atoms the matrix for the combined crystal field effect and spin-orbit coupling is a 33x33 matrix. This matrix factors directly into three 8x8 matrices and one 9x9. The eigenvalues and eigenvectors were obtained for ten 8x8 matrices and five 9x9 matrices.
For nitrogen atoms the eigenvalues and eigenvectors were obtained for fifteen 5x5 matrices.

1102-40-5126/56-171   COLLISION INTEGRALS USED IN TRANSPORT THEORY

Origin and Sponsor: NBS, Section 3.2

Manager: J. Cooper

Full task description: Oct-Dec 1955 issue, p. 33

Status: Continued. A short code to compute the value of

$$ x = \pi - 2b \int_{r_m}^{\infty} \frac{dr/r^2}{\sqrt{1-(\frac{b}{r})^2 - \frac{\emptyset(r)}{g^2}}} $$

for various values of g and b was written to determine the behavior of x using the Morse potential:

$$ \emptyset(r) = 4e^{\beta(1-r)}(e^{\beta(1-r)}-1). $$

To find r_m (the largest root of the denominator) the equation $r_{n+1}=r_n-f(r_n)$,

where $f(r)$ is the expression under the radical sign in the above equation, was solved by iteration. In order to improve convergence it was found convenient to replace $f(r)$ by $\frac{f(r)}{f'(r)}$ and iterate using the form

$$ r_{n+1} = r_n - \frac{f(r_n)}{f'(r_n)} . $$

Convergence using this form in conjunction with an iteration accelerator technique was rapid, and the process converged for all cases tried except when β in the Morse potential was large.
The integration was performed using 16-point Gaussian quadrature on the interval 0 to $1/r_m$, transforming the integral using $\rho = 1/r$.

However, due to the singularity at the upper limit the accuracy was not sufficient. The code has now been modified to compute the integral using the transformation $\frac{1}{r} = \frac{\sin \rho}{r_m}$, which removes the singularity except for

certain values of the parameters b, g and β.

1102-40-5126/56-172 NUMERICAL EVALUATION OF SPECIAL INTEGRAL EXPRESSIONS
Origin and Sponsor: Diamond Ordnance Fuze Laboratory, Department of the Army
Managers: P. Henrici, L. Joel
Objective: To evaluate some principal value integrals of the form

$$P \int_0^\infty \frac{f(x^2)}{x^2-a^2} J_0(xy) \, x \, dx$$

where $f(x^2)$ is an elementary differentiable function for $0 < x < \infty$.
Background: Integrals of this type occur in the theory of elastic vibrations.
In a report by P. M. McQuinlan, "Elastic theory of soil dynamics," p. 3
(Symposium on Dynamic Testing of Soils, ASTM Special Technical Publication
No. 156, 1953), simple cases of transmission of tremors or vibrational
disturbances through surface soils are presented. The current study is
an attempt to complete the analysis of one unresolved aspect in this
report as expressed in the above integral. The integral gives the soil
vibration amplitude at a distance from the source as a function of soil
parameters and experimental conditions. The results of this evaluation
of Quinlan's integral will be compared with other experimental data
obtained at the NBS in an attempt to check the validity of the analysis.
The problem was requested by E. N. Skomal.
Status: New. In order to avoid the singularity in the numerical integration,
one introduces the function

$$g(x^2) = \frac{f(x^2)-f(a^2)}{x^2-a^2}$$

The integral can then be written

$$\int_0^\infty g(x^2)T_0(xy)x \, dx + f(a^2) \, P\left\{\int_0^\infty \frac{1}{x^2-a^2} J_0(xy)x \, dx\right\},$$

where $P\{\ \}$ denotes the principal part of the integral. Here the first
integral has a regular integrand, and the second can be evaluated
explicitly in terms of the Neumann functions.

1102-40-5126/56-173 COMPUTATIONS FOR JOB SATISFACTION INVENTORY
Origin and Sponsor: Public Health Service
Manager: S. Prusch
Objective: To determine and compare distributions of data in a job
  satisfaction inventory, and to compute the χ^2 distribution for each of
  215 items in the inventory.
Background: The computations arise in connection with the study of a job
  satisfaction inventory for five groupings of personnel in three hospitals.
  An attempt is being made to check the relative validity of the 215 items
  with a view to reducing the number to 100. To aid in this it is necessary
  (1) to determine how the distribution of individuals with favorable and
  unfavorable responses to each item compares with the distribution of
  individuals with high and low scores, and (2) to determine how the
  distribution of individuals with favorable and unfavorable responses
  to an item compares with the distribution of individuals who are satisfied
  or dissatisfied as determined by special criteria. This was specifically
  requested by B. Buchbinder of the Public Health Service.
Status: New. The problem was coded, and code-checking is in progress.

1102-40-5126/56-176 **MODEL GOVERNMENT PAYROLL ON HIGH SPEED COMPUTERS**
<u>Origin and Sponsor</u>: NBS, Section 12.5
<u>Manager</u>: G. Hawkins
<u>Objective</u>: To investigate the feasibility of translating the Government
payroll computations to electronic computer operations. This investigation
is to be effected by studying in particular the conversion of the operations
of the NBS payroll system (1) to a large general-purpose computer, and
(2) to a drum computer, and then comparing the efficiency of these two
systems with each other and with an IBM mechanized system.
<u>Background</u>: The NBS payroll system was recently mechanized with IBM
equipment. Biweekly time cards for each employee are submitted to the
Payroll Section. From these, time cards and paychecks are computed and
processed; and various division and bureau reports are derived and used
for time distribution analyses and general accounting procedures. The
present investigation aims to determine whether further time-saving and
efficiency is possible if the material were to be processed on a digital
electronic computer.
<u>Status</u>: New. Coding of the problem for UNIVAC is in progress.

6. STATISTICAL ENGINEERING SERVICES

.COLLABORATION ON STATISTICAL ASPECTS OF NBS
RESEARCH AND TESTING
Task 3737-60-0002/51-1

Origin: NBS   Authorized 7/1/50
Managers: W. J. Youden, J. Cameron
Full task description: July-Sept 1950 issue, p. 60

     Status: CONTINUED. During this quarter members of the Section
provided statistical assistance and advice to a number of Bureau personnel.
The following are representative examples:
    (1) A 3x3 factorial experiment in 9 blocks of 3 units each was
        analyzed for J. Wachtman, Section 9.1, to evaluate the
        characteristics of the modulus of rupture of sapphire single
        crystals with respect to loading rates and temperatures.
    (2) Statistical analyses were made on SEAC for H. C. Allen,
        Section 4.2; W. G. Eicke, Section 1.8; G. W. Cleek, Section
        9.2; J. Hilsenrath, Section 3.2; A. Friedman, Section 3.2;
        M. D. Burkhard, Section 6.1; and R. S. Jessup, Section 3.2.
        In the last two instances special codes were written for SEAC.
    (3) Members of the staff consulted with personnel of the Fire
        Protection Section (10.2) on the scheduling of tests of fire
        protecting finishes for building materials.
    (4) W. J. Youden has been working with W. B. Mann, Section 4.9,
        on experiment designs for the intercomparison of radium
        standards from several national laboratories.
    (5) An analysis of the data on lengths of meter bars was made
        for Section 2.4 to determine the improvement in precision
        due to improved methods of marking lines on the newer bars.
    (6) M. Zelen served as statistical consultant to the members of
        Section 12.5 who are studying the sorting operations of the
        Post Office.

     Publications:
(1) National physical standards and design of experiments. W. J. Youden.
    To appear in Revue de l'Institut International de Statistique.
(2) More scientists. W. J. Youden. Submitted to a technical journal.
(3) A simplified calibration of platinum versus platinum-rhodium thermocouples.
    B. E. Squires (3.1) and M. Zelen. In manuscript.

STATISTICAL SERVICES FOR COMMITTEE ON SHIP STEEL, NRC
Task 1103-40-5105/52-1

Origin and Sponsor: Ship Structure Committee, NRC   Authorized 12/1/51
Manager: W. J. Youden
Full task description: Oct-Dec 1951 issue, p. 58

     Status: CONTINUED. A multiple regression study of the effect of
chemical composition on ship steel was nearly completed.

RESEARCH IN APPLICATIONS OF MATHEMATICAL STATISTICS TO
PROBLEMS OF THE CHEMICAL CORPS
Task 1103-40-5118/52-1

Origin and Sponsor: Biological Laboratories,   Authorized 10/1/51
                    Chemical Corps, Dept. of the Army
Manager: C. Eisenhart
Full task description: Oct-Dec 1951 issue, p. 57

    Status: CONTINUED. A report giving a collection of formulas for
computing probabilities from common statistics was submitted.
        Work on tabulating a function related to problems of diffusion
in the atmosphere was begun.

STATISTICAL ANALYSIS AND DESIGN OF EXPERIMENTS
FOR THE U. S. GEOLOGICAL SURVEY
Task 1103-40-5140/54-1

Origin and Sponsor: U. S. Geological Survey,   Authorized 10/9/53
                    Department of Interior
Managers: C. Eisenhart, W. J. Youden
Full task description: Oct-Dec 1953 issue, p. 50

    Status: CONTINUED. Some quick and easy methods for estimating the
direction of gradient and the properties of such estimators are being
worked out.
        Data supplied by Dorothy Carroll of the Beltsville Laboratories
concerning counts of different kinds of minerals in samples taken from
tributaries of the South River in Virginia were analyzed for the most
abundant mineral, the "opaques," with the aim of deciding how many samples
should be taken from each location in order to get the most information for
a given cost.
        Consultations were held with J. Hack on application of extreme
values and other statistical methods (including order statistics) to
pebble deposits.
        C. Eisenhart visited the U. S. Geological Survey Center, Menlo
Park, California, March 19-24, at their request (i) to acquaint the
geologists at Menlo Park with the uses and usefulness of statistical methods
in laboratory and field studies, and with the necessity of giving adequate
consideration to statistical aspects of such studies in the planning stage;
(ii) to discover in what particular phases of the work going on at Menlo
Park statistical methods might be most advantageously applied; and (iii),
to make some tentative plans for provision of statistical assistance to
the geologists at Menlo Park in the future. While there he gave five
lectures to the staff of the center as follows: (1) Evolution of statistical
method as a research tool; (2) Some canons of sound experimentation;
(3) Principles of sampling; (4) Variance components and optimum allocation
of sampling effort; and (5) Experiment designs. On the final day he
presided over an informal meeting at which (1) representatives from the
Department of Statistics, Stanford University, and the Statistical Laboratory,
University of California, Berkeley, outlined the statistical courses of
potential value to geologists available at these two neighboring educational
institutions, and (2) geologists from the center outlined some of their
problems to the statisticians and sought their advice on them.

MANUAL ON EXPERIMENTAL STATISTICS
FOR ORDNANCE ENGINEERS
Task 1103-40-5146/55-93

Origin and Sponsor: Office of Ordnance Research   Authorized 12/29/54
Manager: C. Eisenhart
Full task description: Oct-Dec 1954 issue, p. 28

    Status: CONTINUED. Drafts of the following sections have now been
completed: "Estimating average performance from a sample," "Estimating
the variability of performance from a sample," "Statistical tests concerning
averages and dispersions." A draft of the section "Description, prediction,
and correlation" is nearly completed, and some work has been done on the
sections "Simple control charts for means and ranges," "Estimating true
proportions or percentages," and "Statistical tests concerning proportions."

APPLICATION

of

NATIONAL BUREAU OF STANDARDS AUTOMATIC COMPUTER (SEAC)

The record of SEAC operations for tasks of the Applied Mathematics Division for the period January 1 through March 31 is as follows:

Task No.	Title	Hours Used: Code Checking	Hours Used: Productive Operation
NBS:			
1104/55-55	Research in numerical analysis	6	
5116/56-148	Nerve fiber reaction		20
1110/47-2	Tables of Coulomb wave functions	9	25
1110/52-57	Sieverts integral		2
1110/53-51	Radiation diffusion III	17	42
1110/53-52	L-Shell conversion coefficients		24
1110/55-65	Automatic coding	2	
5126/52-44	Calculations for d-spacings		14
5126/53-29	Dynamic behavior of aircraft structure	5	19
0009/54-17	Depolymerization	1	16
5126/54-30	Spectrometer analysis	1	1
0009/55-53	Electronic functions		10
0009/55-75	Parameter of the dispersion equation for optical glass	1	3
5126/55-81	Combining tests for significance	2	55
5126/55-87	Crystal structure	10	
5126/55-97	High temperature properties of air	39	22
5126/55-118	Thermometer calibrations	14	4
5126/55-121	Electron penetration	2	
5126/55-124	Evaluation of integrals related to gas flow	6	4
5126/55-127	Vibrations of circular disc	10	19
5126/56-166	SCF-LCAO solution of some hydrides	13	
0009/56-131	Ray tracing	69	85
5126/56-134	Transmission delay times		1
5126/56-139	Study of internuclear potential for H_3	10	13
5126/56-150	Mathematical expression		3
5126/56-169	Crystal field effects for atoms		20
5126/56-171	Collision integrals used in transport theory	6	4
5126/56-179	Normal propagation constant	27	51
5126/56-178	Cytac	3	2
0002/52-1	Statistical aspects of administrative operations	6	36
Misc.	Training		1
"	Least squares		2
Other:			
5126/53-45	Application of game theory	4	5
5126/54-13	Award of procurement contracts for linear programming		12

Task No.	Title	Hours Used: Code Checking	Hours Used: Productive Operation
Other:			
5126/55-104	"Fuse" problem	1	58
5126/55-113	Reactor design	3	78
5126/55-119	Field rocket problem	10	
5126/56-130	Aircraft responses	6	2
5126/56-133	Complex eigenvalues	1	3
5126/56-136	Calculation of wave functions	6	32
5126/56-137	Stability of supported plates		22
5126/56-138	Crystal counter efficiency	3	
5126/56-140	Multiple correlation routines	15	5
5126/56-149	Logical matrix multiplication	4	3
5126/56-151	Cross section measurements	1	41
5126/56-163	Nuclear scattering	9	5
5126/56-165	Integrals for scattering functions	13	1
5126/56-167	Multiple regression	1	
5126/56-172	Special integral expressions	1	
5126/56-173	Job satisfaction inventory	9	
5126/56-181	Coulomb – AEC		27
5160/55-85	Mathematical elasticity	3	106
5160/56-156	Mathematical geophysics	13	7

Lectures and Symposia

Note: In general, copies of papers or talks listed in this section are not available from the National Bureau of Standards. If and when a paper is to be published, it will be listed in the section of this report on Publication Activities.

Participation in NBS Scientific Staff Meetings

STONELEY, R. (Cambridge University) The thickness of the continents. February 10.

SYNGE, J. L. (Institute for Advanced Studies, Dublin) The concept of time. March 9.

Applied Mathematics Division Seminar

ARONSZAJN, A. (University of Kansas) Survey of the work in progress on partial differential equations, in particular eigenvalue problems at the University of Kansas. March 9.

Seminar: Special Topics in Numerical Analysis

(Offered by the Department of Mathematics of The American University in collaboration with the Graduate School of the National Bureau of Standards)

TODD, J. (1) The theorems of Markoff. January 10. (2) The theorem of Zolotareff. January 17.

Algebra Seminar

(Offered by the Department of Mathematics of The American University in collaboration with the Graduate School of the National Bureau of Standards)

GORN, S. (Moore School of Electrical Engineering, University of Pennsylvania) Computations in cubic field. February 13.

NEWMAN, M. A theorem of Mordell concerning positive quadratic forms, I, II. February 20, 29.

TODD, J. Number theory in quaternions. March 7.

TAUSSKY-TODD, O. Mordell's theory of positive binary quadratic form. March 14.

MARSHALL, L.C. (Department of Defense) General theory of binary quadratic form I, II. March 21, 28.

Statistical Theory Seminar

(Offered jointly by the National Institutes of Health and the National Bureau of Standards.)

CORNFIELD, J. (NIH). Models in the analysis of variance. January 17.

ROSENBLATT, J. R. (NBS) The efficiency of statistical tests. February 17.

Applied Statistics Seminar

(Offered jointly by the National Institutes of Health and the National Bureau of Standards.)

MEIER, P. (Johns Hopkins University) Some statistical aspects of safety testing of vaccines. March 16.

Mathematical Physics Section Seminar

STONELEY, R. (Cambridge University) Theory of elastic surface waves. Three lectures: February 9, 16, 23.

SYNGE, J. L. (Institute for Advanced Studies, Dublin) Elastic waves in anisotropic media. March 8.

Papers and Invited Talks
Presented by Members of the Staff
at Meetings of Outside Organizations

ABRAMOWITZ, M. The evaluation of special functions on high speed computers. Presented at the Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, February 8.

CHIARULLI, P. Applied mathematics and the atomic bomb. Presented at a meeting of Sigma Pi Sigma, Howard University, Washington, D.C., January 18.

EISENHART, C. (1) Evolution of statistical method as a research tool. (2) Some cannons of sound experimentation. (3) Principles of sampling. (4) Variance components and optimum allocation of sampling effort. (5) Experiment designs. A series of lectures presented to the staff of the U. S. Geological Survey Center, Menlo Park, California, March 19-23.

HOCHSTRASSER, U. Methods and tools in applied mathematics. (1) Presented at a meeting of Sigma Pi Sigma, Howard University, Washington, D. C., February 17, and (2) Presented to the Research and Development Group, Naval Powder Factory, Indian Head, Md., February 29.

HOFFMAN, A. J. (1) Cross sections of two families of sets. Presented at a meeting of the Logistics Research Project, George Washington University, Washington, D. C., February 2. (2) Integral solutions of linear programming problems. Presented to the Industrial Engineering Department of Johns Hopkins University,

Baltimore, Md., February 15. (3) Representatives of sets.
Presented at a Combinatorial Problems Seminar, Princeton
University, Princeton, N. J., March 19.

STONELEY, R. (Guest Worker, from Cambridge University).
(1) The interior of the earth. Presented at the National
Academy of Sciences, Washington, D. C., January 10. (2) The
propagation of elastic waves over the surface of a cubic
crystal. Presented at the Exploration and Production Research
Laboratory, Shell Development Co., Houston, Tex., January 17.
(3) The thickness of continents. Presented at the Agricultural
and Mechanical College of Texas, College Station, Texas,
January 19. (4) The variation of amplitude with depth in
Rayleigh waves. Presented before the Seismological Society of
America, Reno, Nevada, March 30.

SYNGE, J. L. (Guest Worker, from Institute for Advanced Studies, Dublin).
(1) Classical dynamics and de Broglie waves. Presented at
New York University, February 6; at Princeton University,
February 7; at Brown University, February 9; at the Ballistic
Research Laboratory, Aberdeen Proving Ground, Md., February 21;
at the Carnegie Institute of Technology, Pittsburgh, Pa.,
March 1; at the Institute for Fluid Dynamics and Applied
Mathematics, University of Maryland, March 28. (2) Geometrical
optics in moving media. Presented at Harvard University,
Cambridge, Mass., March 6. (3) Classical dynamics and optics:
de Broglie waves and photons. Presented to the Department of
Mathematics, University of California at Los Angeles, March
13, 14. (4) Elastic waves in anisotropic media. Presented
at the Massachusetts Institute of Technology, Cambridge, Mass.,
March 7. Also presented at the Geophysical Institute, University
of California at Los Angeles, March 15-16.

TAUSSKY-TODD, O. (1) Pencils of matrices. Presented at the Institute for
Fluid Dynamics, University of Maryland, College Park, Md.,
February 17. (2) Characteristic roots of sums and products
of finite matrices. Presented at the Naval Ordnance Laboratory,
White Oak, Md., January 18.

YOUDEN, W. J. (1) Design of experiments in the physical sciences. Presented
at the Nuclear Power Division of the Bureau of Ships, Washington,
D. C., January 3. (2) Interpretation of chemical data. Presented
before the local chapter of the American Chemical Society,
Morgantown, W. Va., January 9. (3) Control of experimental error
by statistical design. Presented before the local chapters of
the American Chemical Society in Charleston, W. Va.; Cincinnati,
Ohio; and Lexington, Ky., January 10-12.
(4) Making good measurements. Presented before the
Indianapolis Chapter of the American Statistical Association,
Indianapolis, Ind., January 13. (5) Experimental designs for
the physical sciences. Presented before a joint meeting of the
Minnesota ASQC and the American Institute of Chemical Engineers,
St. Paul, Minn., January 17, and also before a group of scientists
and engineers at the Westinghouse Electric Corp., Bettis Plant,
Pittsburgh, Pa., March 2.
(6) Improvement in the technique of learning. Presented
before the professional staff of the Baltimore County Board of
Education, Towson, Md., January 30. (7) Dice, data, and deductions.
Presented before the Physics Club and Chemical and Mathematics
Societies of Trinity College, Washington, D. C., February 1,
and also before the Mathematics Club, Woodrow Wilson High School,
Washington, D. C., February 28.

(8) Statistics for novices. Presented at the Sixth Annual
Convention Textile Division, ASQC, Charlottesville, Va.,
February 13.
          (9) Design of experiments. Presented before the
Youngstown Section of ASQC, Youngstown, Ohio, March 1. (10) Design
of experiments in research and development. Presented before
the Washington Chapter, American Society for Metals, March 12.
(11) Cubes, colors, and computations. Presented before the
Roosevelt High School Science Club, Washington, D. C., March 19.

Publication Activities

1. PUBLICATIONS THAT APPEARED DURING THE QUARTER

1.3 Technical Papers

(1) Analytic study of war games. H. Antosiewicz. Naval Research Logistics Quart. 2, 181-215 (Sept. 1955).

(2) Chaînes de Markof dans les ensembles abstraits et applications aux processus avec régions absorbantes et au problème des boucles. (Formerly, Time-discrete stochastic processes in arbitrary sets, with applications to processes with absorbing regions and to the problem of loops in Markoff chains.) D. van Dantzig. Ann. Inst. H. Poincaré 14, 145-199 (1955).

(3) Abscissas and weights for Gaussian quadratures of high order. P. Davis and P. Rabinowitz. J. Res. NBS 56, 35-37 (Jan. 1956), RP2645.

(4) Numerical experiments in potential theory using orthonormal functions. P. Davis and P. Rabinowitz. J. Wash. Acad. Sci. 46, 12-17 (1956).

(5) Comparison of theories and experiments for the hydraulic dam-break wave. R. F. Dressler. Publication No. 38 de l'Association Internationale d'Hydrologie (Assemblee generale de Rome, 1954, tome III, p. 319-328). Extrait.

(6) Heat flow in a fluid with eddying flow. W. H. Durfee (now at Mt. Holyoke College). Condensed version appears in J. Aero. Sci. 23, 188-189 (Feb. 1956).

(7) A comparison theorem for eigenvalues of normal matrices. K. Fan. Pac. J. Math. 5, Supp. 2, 911-913 (1955).

(8) A subroutine for computations with rational numbers. P. Henrici. J. Assoc. Comp. Mach. 3, 6-9 (Jan. 1956).

(9) Automatic computations with power series. P. Henrici. J. Assoc. Comp. Mach. 3, 10-15 (Jan. 1956).

(10) On generating functions of the Jacobi polynomials. P. Henrici. Pac. J. Math. 5, 923-931 (1955).

(11) Commutators of A and A*. T. Kato (University of Tokyo) and O. Taussky. J. Wash. Acad. Sci. 46, 38-40(1956).

(12) Pairs of matrices with property L, II. T. S. Motzkin (University of California at Los Angeles) and O. Taussky. Trans. Amer. Math. Soc. 80, 387-401 (Nov. 1955).

(13) An alternative proof of a theorem on unimodular groups. M. Newman. Proc. Amer. Math. Soc. 6, 998-1000 (1955).

(14) The normalizer of certain modular subgroups. Canadian J. Math. <u>8</u>,
      29-31 (1956).

(15) On a generalization of the normal basis in abelian algebraic number
      fields. M. Newman and O. Taussky. Comm. Pure Appl. Math. (NYU)
      <u>9</u>, 85-91 (1956).

(16) On asymptotic series for functions occurring in the theory of
      diffraction of waves by wedges. F. Oberhettinger. J. Math. Phys.
      <u>34</u>, 245-255 (Jan. 1956).

(17) Determinanten mit ueberwiegender Hauptdiagonale und die absolute
      Konvergenz von linearen Iterationsprozessen. A. M. Ostrowski.
      Comment. Math. Helv. <u>30</u>, 175-210 (1956).

(18) Contributions for inverse osculatory interpolation. H. E. Salzer.
      (Department of the Army). J. Res. NBS <u>56</u>, 51-54 (Jan. 1956),
      RP2647.

(19) A note on group matrices. O. Taussky. Proc. Amer. Math. Soc. <u>6</u>,
      984-986 (1955).

(20) Partially replicated latin squares. W. J. Youden and J. S. Hunter
      (American Cyanimid Co.). Biometrics <u>11</u>, 399-405 (Dec. 1955).

2. MANUSCRIPTS IN THE PROCESS OF PUBLICATION MARCH 31, 1956

2.1 Mathematical Tables

(1) A table of the coefficients of the powers $\eta(\tau)$. M. Newman. To
      appear in the Proceedings of the Royal Netherlands Academy of
      Sciences.

2.2 Manuals, Bibliographies, and Indices

(1) Analyzing straight line data. F. S. Acton. To appear as a book
      in the Applied Statistics Series of the Wiley Publications in
      Statistics.

(2) Fractional factorial experimental designs for factors at two
      levels. W. S. Connor, M. Zelen, L. Deming, and W. H. Clatworthy.
      To appear as NBS Applied Mathematics Series 48.

2.3 Technical Papers

(1) On the differential equation $\ddot{x} + k(f(x) + g(x)\dot{x})\dot{x} = ke(t)$.
      H. A. Antosiewicz. Submitted to a technical journal.

(2) Stable systems of differential equations with integrable forcing
      term. H. A. Antosiewicz. To appear in the Journal of the London
      Mathematical Society.

(3) Easily used simultaneous confidence limits for a line. W. S. Connor.
      Submitted to a technical journal.

(4) Dilworth's theorem on partially ordered sets. G. B. Dantzig (RAND)
      and A. J. Hoffman. To appear in "Papers on linear inequalities
      and related systems," Annals of Mathematics Study 38.

(5) Uniqueness theory for asymptotic expansions in general regions.
      P. Davis. To appear in the Pacific Journal of Mathematics.

(6) Complete sequences and approximations in normed linear spaces.
P. Davis and K. Fan. Submitted to a technical journal.

(7) Some Monte Carlo experiments in computing multiple integrals.
P. Davis and P. Rabinowitz. To appear in Mathematical Tables and
Other Aids to Computation.

(8) Entropy changes in rarefaction waves. R. F. Dressler. Submitted
to a technical journal.

(9) On systems of linear inequalities. K. Fan. To appear in "Papers
on linear inequalities and related systems," Annals of Mathematics
Study 38, ed. by H. W. Kuhn and A. W. Tucker.

(10) Systems of inequalities involving convex functions. Ky Fan.
Submitted to a technical journal.

(11) A note on the normal distribution. S. Geisser. To appear in Annals
of Mathematical Statistics.

(12) A matrix with real characteristic roots. K. Goldberg. To appear
in the Journal of Research (NBS).

(13) The formal power series for $\log e^x e^y$. K. Goldberg. To appear in
the Duke Journal of Mathematics.

(14) On the domain of regularity of generalized axially symmetric
potentials. P. Henrici. To appear in the Proceedings of the
American Mathematical Society.

(15) On the representation of a certain integral involving Bessel functions
by hypergeometric series. Submitted to a technical journal.

(16) On systems of distinct representatives. A. J. Hoffman and H. W. Kuhn
(Bryn Mawr College). To appear in "Papers on linear inequalities
and related systems," Annals of Mathematics Study 38.

(17) Systems of distinct representatives and linear programming.
A. J. Hoffman and H. W. Kuhn (Bryn Mawr College). To appear in
the American Mathematical Monthly.

(18) The number of absolute points of a correlation. A. J. Hoffman,
M. Newman, E. G. Straus, O. Taussky. To appear in the Pacific
Journal of Mathematics.

(19) On the Hilbert matrix. T. Kato. Submitted to a technical journal.

(20) Applications of extreme value theory to cobbles and boulders in
gravel pits. W. C. Krumbein (Northwestern University) and
J. Lieblein. Submitted to a technical journal.

(21) Solvability and consistency for linear equations and inequalities.
H. W. Kuhn (Bryn Mawr College). To appear in the American Mathematical
Monthly.

(22) An inclusion theorem for modular groups. M. Newman. Submitted to a
technical journal.

(23) Generalizations of identities for the coefficients of certain modular
forms. M. Newman. To appear in the Journal of the London Mathematical
Society.

(24) On the existence of identities for the coefficients of certain modular forms. M. Newman. To appear in the Journal of the London Mathematical Society.

(25) The diophantine equation $ax^m - by^n = c$. M. Newman. Submitted to a technical journal.

(26) On the Lerch zeta function. F. Oberhettinger. To appear in the Pacific Journal of Mathematics.

(27) On Gauss' speeding up device in the theory of single step iteration. A. M. Ostrowski. Submitted to a technical journal.

(28) On the convergence of Gauss' alternating procedure in the method of the least squares, I. A. M. Ostrowski. Submitted to a technical journal.

(29) Contributions to the theory of rank order statistics. I. R. Savage. To appear in the Annals of Mathematical Statistics.

(30) On the independence of tests of randomness and other hypotheses. I. R. Savage. To appear in the Journal of the American Statistical Association.

(31) The transmission of Rayleigh waves across an ocean floor with two surface layers. R. Stoneley. Submitted to a technical journal.

(32) Algebraic equations satisfied by roots of natural numbers. E. G. Straus (University of California at Los Angeles) and O. Taussky. To appear in the Pacific Journal of Mathematics.

(33) Some computational problems in algebraic number theory. O. Taussky. To appear in the Proceedings of the American Mathematical Society Sixth Symposium on Applied Mathematics, held at Santa Monica City College, August 1953.

(34) Generation and testing of pseudo-random numbers. O. Taussky and J. Todd. To appear in the Proceedings of a Symposium on Monte Carlo methods, held at Gainesville, Fla., 1954.

(35) A direct approach to the problem of stability in the numerical solution of partial differential equations. To appear in the Proceedings of a Symposium on Partial Differential Equations held at Berkeley, California, 1955.

(36) National physical standards and design of experiment. W. J. Youden. To appear in Revue de L'Institut International de Statistique (The Hague).

(37) Exact tests of significance for combining intra- and inter-block information. M. Zelen. Submitted to a technical journal.

(38) On the analysis of covariance. M. Zelen. Submitted to a technical journal.

2.5 Miscellaneous items

(1) Development of automatic computers. F. L. Alt. To appear in the Proceedings of the American University Institute on Electronics in Management, held in Washington, D. C., November 1955.

(2) Contributions on partially balanced incomplete block designs with two associate classes. W. H. Clatworthy. To appear as NBS Applied Mathematics Series 47.

(3) More scientists. W. J. Youden. Submitted to a technical journal.

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

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Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($0.75), available from the Superintendent of Documents, Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.