# NATIONAL BUREAU OF STANDARDS REPORT

5140

## PROJECTS and PUBLICATIONS
of the
### APPLIED MATHEMATICS DIVISION

A Quarterly Report
October through December 1956

<NBS>

## U. S. DEPARTMENT OF COMMERCE
## NATIONAL BUREAU OF STANDARDS

# THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D. C., and its major field laboratories in Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out 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 back cover of this report.

## WASHINGTON, D. C.

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

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

**Heat and Power.** Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology 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. Metals Physics.

**Mineral Products.** Engineering Ceramics. 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.** SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analogue Systems. Application Engineering.

• Office of Basic Instrumentation                    • Office of Weights and Measures

## BOULDER, COLORADO

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

**Radio Propagation Physics.** Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships.

**Radio Propagation Engineering.** Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering.

**Radio Standards.** Radio Frequencies. Microwave Frequencies. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Calibration Center. Microwave Physics. Microwave Circuit Standards.

# NATIONAL BUREAU OF STANDARDS REPORT

**NBS PROJECT**

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**NBS REPORT**

5140

# PROJECTS and PUBLICATIONS

## of the

## APPLIED MATHEMATICS DIVISION

## October through December 1956

◁NBS▷

# U. S. DEPARTMENT OF COMMERCE
# NATIONAL BUREAU OF STANDARDS

# APPLIED MATHEMATICS DIVISION

October 1 through December 31, 1956

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# CONTENTS

*Only unclassified projects are included in this report.

# Status of Projects

December 31, 1956

## 1. NUMERICAL ANALYSIS

### RESEARCH IN THEORIES OF DISCRETE STRUCTURES
Task 1100-11-5170/56-159

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-Todd has completed the manuscript of her lecture, "Some computational problems concerning matrices with integral elements" (see publication (14) below).

O. Taussky-Todd and M. Newman continued work on positive definite unimodular circulants with integral coefficients. They had proved previously that for n=8 such circulants lie in two different classes. They are now examining the possible classes for larger n, particularly for n=12 when at least three classes are possible.

O. Taussky-Todd is studying the three-class group of imaginary quadratic fields $R(\sqrt{-d})$ with $d \equiv 5(8)$.

M. Newman is studying the integral automorphs of integral circulant matrices. It was shown in this connection that if n is odd, then the circulant

$$P = \begin{pmatrix} 0 & 1 & 0 & . & . & . & 0 \\ 0 & 0 & 1 & . & . & . & 0 \\ . & . & . & & & & . \\ . & . & . & & & & . \\ . & . & . & & & & . \\ 1 & 0 & 0 & . & . & . & 0 \end{pmatrix}$$

has only the automorphs $\pm P^k$, while if n is even there are in general an infinity of automorphs, whose structure is fully described.

H. Cohn is now writing a paper on numerical studies of the class number of the pure cubic field.

Publications:
(1) On the Hilbert matrix. T. Kato. To appear in the Proceedings of the American Mathematical Society.

(2) Classes of positive definite unimodular circulants. M. Newman and
    O. Taussky. To appear in the Canadian Journal of Mathematics.
(3) Unimodular matrices of order two which commute. K. Goldberg. J.Wash.
    Acad. Sci. 46, 337-338 (1956).
(4) Incidence algebras. E. C. Dade and K. Goldberg. In manuscript.
(5) Commutativity in finite matrices. O. Taussky. To appear in the
    American Mathematical Monthly.
(6) Classes of matrices. O. Taussky. To appear in the Illinois Journal
    of Mathematics.
(7) The number of representations of a quadratic form as a sum of four
    squares. G. Pall (Illinois Institute of Technology) and O. Taussky.
    Submitted to a technical journal.
(8) Commuting bilinear transformations and matrices. O. Taussky and
    J. Todd. To appear in the Journal of the Washington Academy of Sciences.
(9) Pairs of matrices of order two which generate free groups. K. Goldberg
    and M. Newman. To appear in the Illinois Journal of Mathematics.
(10) A method for computing eigenvectors. K. Goldberg. In manuscript.
(11) Some algebraic number theory estimates based on the Dedekind eta-
    function. H. Cohn. Amer. J. Math. 78, 791-796 (1956).
(12) A computation of cyclic cubic units. H. Cohn and S. Gorn (Moore
    School of Engineering). To appear in the Journal of Research, NBS.
(13) Numerical studies of the class number of the pure cubic field.
    H. Cohn. In manuscript.
(14) Some computational problems concerning integral matrices. O. Taussky.
    To appear in the Proceedings of the 1956 meeting of the Italian
    Society for the Advancement of Science, held in Sicily.

## 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. J. Todd completed the manuscript of his
lecture "Computational problems concerned with the Hilbert matrix"
(see publication (13) below).

M. Newman and J. Todd are preparing a report on the evaluation
of matrix inversion programs. A series of matrices, with condition
number increasing from unity (for an orthogonal matrix) to exp $(\alpha_n)$ for
an nxn Hilbert matrix, are being inverted on SEAC using the most efficient
SEAC code available. Included are sparse matrices and full matrices
with the same condition number, and also positive definite matrices and
indefinite matrices. In each case various norms of the error are being
computed. It is hoped that other organizations will carry through
similar tests with their best inversion programs. Examination of the
results of such tests would give some idea of the relative merits of the

various programs and would suggest the ones that deserve a theoretical error-estimation.

H. A. Antosiewicz has begun a study of the problem of reducibility of linear systems of first order ordinary differential equations. A system $\dot{x}=A(t)x$ is reducible on $[0,\infty)$ if there exists a differentiable $Z(t)$, bounded together with $Z^{-1}(t)$ on $[0,\infty)$, such that if $y=Z^{-1}(t)x$ then $\dot{y}=Cy$, where C is constant. He has obtained refinements of theorems of Wintner and Yakubovic concerned with sufficient conditions on $B(t)$ such that $\dot{x}=[C+B(t)]x$ is reducible to $\dot{y}=Cy$. These results lead to important applications in the study of asymptotic representations for solutions in the neighborhood of an irregular singular point. A manuscript is in preparation.

M. Marcus has obtained an upper bound on the sum of the squares of the r-th order subdeterminants of a doubly stochastic matrix of rank k. This bound is $\binom{k}{r}$. As a result of this the following characterization of n-square permutation matrices is obtained: Let S be a doubly stochastic matrix of rank k. Then S has $\binom{k}{r}$ subdeterminants of value $\pm 1$ if and only if k=n and S is a permutation matrix (see publication (7) below).

A second problem being considered by Dr. Marcus is the maximum value taken on by

$$\prod_{j=1}^{k} \left| (Ax_j, x_j) \right| ,$$

where A is n-square normal and $x_1, \ldots, x_k$ is an orthonormal set. This problem is solved for k=2 but for k > 2 only partial results have been obtained. Recently L. K. Hua (Math. Rev. $\underline{17}$, 703 (1956)) proved that

$$\det \left| (I-A*B) \right|^2 \geq \det (I-A*A) \cdot \det (I-B*B)$$

when I-A*A > 0 and I-B*B > 0. Under the same conditions Dr. Marcus has proved that for $k \leq n$ (the size of the matrices)

$$\prod_{j=1}^{k} \left| \lambda_{n-j+1} \right|^2 > \prod_{j=1}^{k} (1-\alpha_j)(1-\beta_j)$$

where $\left| \lambda_j \right|$, $\alpha_j$, $\beta_j$ are respectively the absolute values of the eigenvalues of A, the eigenvalues of AA* and the eigenvalues of BB* arranged in decreasing order (see publication (8) below).

H. Cohn has written a paper on the global equilibrium theory of charges on a circle.

Publications:
(1) A direct approach to the problem of stability in the numerical solution of partial differential equations. J. Todd. Appeared: Comm.Pure Appl. Math. $\underline{9}$, 597-612 (1956). Also to appear in the Proceedings of a Symposium on Partial Differential Equations, held at

Berkeley, California, 1955.

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

(3) Note on bounds for certain determinants. E. V. Haynsworth. Submitted to a technical journal.

(4) A survey of Lyapunov's second method. H. A. Antosiewicz. To appear in Annals of Mathematics Studies.

(5) Convex functions of quadratic forms. M. Marcus. In manuscript.

(6) Some inequalities for quadratic forms and eigenvalues. M. Marcus. Submitted to a technical journal.

(7) On subdeterminants of doubly stochastic matrices. M. Marcus. In manuscript.

(8) A note on symmetric functions of eigenvalues. M. Marcus and R. Thompson (University of British Columbia). To appear in the Duke Journal of Mathematics.

(9) On a determinantal inequality. M. Marcus. Submitted to a technical journal.

(10) Some extreme value results for indefinite Hermitian matrices. M. Marcus, B. N. Moyles and R. Westwick (University of British Columbia). Submitted to a technical journal.

(11) Extreme value properties of Hermitian matrices. M. Marcus. To appear in Journal of London Mathematical Society.

(12) Extremal properties of Hermitian matrices. M. Marcus and J. L. McGregor (California Institute of Technology). Canadian J. Math. 8, 524-531 (1956).

(13) Computational problems concerned with the Hilbert matrix. J. Todd. To appear in the Proceedings of the 1956 meeting of the Italian Society for the Advancement of Science, held in Sicily.

The following papers appeared in Annals of Mathematics Study 36, "Contributions to the theory of nonlinear oscillations," Vol. III. (Princeton University Press, Princeton, N.J., 1956):

(14) An invariant surface theorem for a non-degenerate system. M. Marcus. Pp. 243-256.

(15) Repeating solutions for a degenerate system. M. Marcus. Pp. 261-268.

(16) A note on the existence of periodic solutions of differential equations. S. P. Diliberto (University of California) and M. Marcus. Pp. 237-241.

## 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
Managers: J. Todd, M. Newman
Full task description: July-Sept 1954 issue, p. 5

Status: CONTINUED. P. Davis has computed on SEAC the first 15

"Lebesgue constants" for equidistant Lagrangian interpolation. These constants, which are of importance in certain problems of interpolatory function theory, are defined as follows:

$$\lambda_n = \max_{0 \le x \le 1} \sum_{k=0}^{n} \left| \frac{(x-x_0)\dots(x-x_{k-1})(x-x_{k+1})\dots(x-x_n)}{(x_k-x_0)\dots(x_k-x_{k-1})(x_k-x_{k+1})\dots(x_k-x_n)} \right|$$

where $x_k = k/n$ $(k=0,1,\dots,n)$. A paper describing numerical applications of these constants to problems of interpolation and approximation is being prepared.

P. Davis has continued his numerical experiments in computing Tschebyscheff approximations ($L^\infty$) using orthonormalizing codes.

M. Newman completed a manuscript entitled "Construction and application of a class of modular functions." It is shown how polynomial bases for certain modular subgroups may be obtained from the functions under consideration, and a new method for determining the modular equations of arbitrary level is described. A numerical example of a polynomial basis for a particular modular subgroup is worked out in detail. This required rather a large amount of computation, which was performed on SEAC.


Publications:
(1) On dominant eigenvalues of positive matrices. T. Kato. In manuscript.
(2) Systems of distinct representatives and linear programming. A. J. Hoffman and H. W. Kuhn (Bryn Mawr College). Amer. Math. Mo. 63, 455-460 (1956).
(3) On the minimization of concave and convex functionals. G. B. Dantzig (RAND Corporation), A. J. Hoffman, W. Hirsch (New York University). In manuscript.
(4) The lowest frequency of a free square plate. H. Fujita (University of Tokyo), T. Kato, Y. Nakata (University of Tokyo), and M. Newman. To appear in the Journal of Research, NBS.
(5) An inclusion theorem for modular groups. M. Newman. To appear in the Proceedings of the American Mathematical Society.
(6) Systems of inequalities involving convex functions. Ky Fan (Notre Dame University), I. Glicksberg (RAND Corporation) and A. J. Hoffman. To appear in the Proceedings of the American Mathematical Society.
(7) Some theorems on $P_r(n)$. M. Newman. To appear in the Canadian Journal of Mathematics.
(8) Construction and application of a class of modular functions. M. Newman. To appear in the Proceedings of the London Mathematical Society.
(9) Numerical computation of the transfinite diameter of two collinear segments. P. Davis. To appear in the Journal of Research, NBS.
      The following papers appeared in Annals of Mathematics Study 38. "Papers on linear inequalities and related systems," (Princeton University Press, Princeton, N. J., 1956):
(10) On systems of distinct representatives. A. J. Hoffman and H. W. Kuhn (Bryn Mawr College). Pages 199-206.

(11) Systems of linear inequalities.  K. Fan.  Pages 99-156.
(12) Dilworth's theorem on partially ordered sets.  G. B. Dantzig (RAND
     Corporation) and A. J. Hoffman.  Pages 207-214.
(13) Integral boundary points of convex polyhedra.  A. J. Hoffman and
     J. B. Kruskal (Princeton University).  Pages 223-246.


## 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 number of cases for a certain temperature
has been run in the continued search for solutions of the basic system of
differential equations having a prescribed behavior.  At a higher
temperature 22 cases have been computed as third approximation, between
the previously obtained two best approximations, in which the interval
of the critical parameter had been determined to be less than $10^{-10}$.  A
fourth approximation has been started.
        In the evaluation of the function $\Lambda(z_o)$ further sets of
parameter values were considered and a number of computations were carried
out.  Test cases that were run to yield error estimates indicate that,
in most instances, four figure accuracy is obtained.


## NUMERICAL EXPERIMENTS ON POTENTIAL THEORY
### USING THE NEHARI ESTIMATES
### Task 1101-10-5116/56-189

Origin:  NBS                                          Authorized 7/10/56
Sponsor:  Air Research and Development Command, USAF
Managers:  P. Davis, U. Hochstrasser
Full task description:  Apr-June 1956 issue, p. 6

        Status:  CONTINUED.  The computations have been completed and a
manuscript describing the results has been prepared.

## 2. MATHEMATICAL TABLES AND PROGRAMMING RESEARCH

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

Manager: I. Stegun                                   Authorized 7/1/47
Full task description: Apr-June 1949 issue, p. 41

    Status: CONTINUED. Checking of the final manuscript continued.


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

Origin: NBS                                         Authorized 7/1/47
Manager: M. Abramowitz
Full task description: Apr-June 1949 issue, p. 45

    Status: CONTINUED. Computation of $F_o$, $F_o'$, $G_o$ and $G_o'$ for $\eta = 0(.5)25$, $\rho = 0(.5)40$ is continuing on a stand-by basis. Checking of the computations has started and preliminary investigations indicate that the final results may probably be given to an accuracy of six significant figures.


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

Origin: Section 11.3, NBS                           Authorized 3/26/51
Manager: S. Peavy
Full task description: Apr-June 1951 issue, p. 49

    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                                                    Authorized 8/10/51
Managers: W. F. Cahill, I. Stegun
Full task description: July-Sept 1951 issue, p. 41

   Status:  INACTIVE.  For status to date, see Jan-Mar 1956 issue,

## 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 final manuscript--in a form
suitable for publication--was completed.


## 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,

## 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. The original project is completed. It is now
believed desirable to consider the nucleus not as a point mass but as a
sphere of finite radius for certain of the high atomic number cases for
the K and $L_I$ shells. These routines are in the process of being written.

### AUTOMATIC CODING
### Task 3711-60-1120/55-65

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

     Status: CONTINUED. Weekly seminars were given on programming for
the IBM 704. The National Bureau of Standards became a member of SHARE
and now maintains a library of SHARE routines and information. Preliminary
plans were made for a system for using the NBS 704 computer which will
facilitate rapid and easy code checking as well as problem solution.

### 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.  E. Haynsworth has started a preliminary study for the preparation of a general orthonormalizing routine for the IBM 704.

A code was written and checked out for the computation of the characteristic polynomial of a real matrix according to a method due to K. Hessenberg (see R. Zurmuhl, Praktische Mathematik für Ingenieure and Physik, pp. 136-147 (Springer, Berlin, 1953)).  It is aimed to complete the code so that it computes also the characteristic roots and the characteristic vectors.

A code for finding the characteristic polynomial of any real matrix has been prepared and checked out on SEAC, with the intent to provide computational means for eigenvalue problems involving non-symmetric matrices.  In its present form the code is applicable to matrices of order $n \leq 22$.  The method used is an elimination process suggested by Voetter(Zeit. Angew. Math. Phys. $\underline{3}$, 1952).  Two modifications are now being added:  The first provides a "conditioning" of the matrix after each step of elimination.  The second deals with special situations in which the method, as originally suggested, fails.  A simple way has been found to obtain, in these situations, the characteristic polynomial in the form of a product of two or more polynomials.


# HANDBOOK OF MATHEMATICAL FUNCTIONS
## Task 1102-40-5113/57-216

Origin and Sponsor:  National Science Foundation        Authorized 12/27/56
Manager:  M. Abramowitz

Objective:  To prepare a Handbook of Mathematical Functions with tables, formulas and graphs.  The introductory chapter will describe the general plan of the volume and also the various methods of interpolation with particular reference to the use of the tables.

The following chapters are to be included:
1. Powers, roots and related functions
2. Binomial coefficients, Bernoulli numbers
3. Fundamental constants
4. Circular and hyperbolic functions
5. Sine, cosine, exponential and logarithmic integrals
6. Gamma and related functions
7. Error function, Fresnel integral
8. Legendre functions
9. Bessel functions
    (a) Integral order
    (b) Spherical, modified spherical, fractional order
    (c) Complex argument
    (d) Integrals
    (e) Struve functions

10. Elliptic functions and integrals
11. Mathieu functions, spheroidal wave functions
12. Parabolic cylinder functions
13. Hypergeometric functions
14. Confluent hypergeometric functions
15. Miscellaneous functions
16. Orthogonal polynomials
17. Statistical tables
18. Interpolation coefficients, quadrature
19. Radix conversion
20. Combinatorial analysis

The volume as planned will contain 750 pages of tables, 200 pages of text and about 50 pages of graphs. Radix tables and auxiliary functions will also be given.

Accompanying each chapter there will be a list of the most important definite and indefinite integrals, infinite series, inequalities, recurrence relations, power series, asymptotic functions, and rational approximations.

Interrelations of the various functions will be emphasized and an index will be given which will cross-reference the function with related functions.

Background: Numerical tables of mathematical functions are continually needed and used by scientists and engineers--for preliminary surveys of problems before programming for machine solution and by those who do not have easy and quick access to machines. The proposed one-volume handbook would satisfy the need as well as acquaint users with new functions.

The need for such a handbook was originally discussed at the Conference on Mathematical Tables held at Cambridge, Mass., in 1954, under the auspices of the Massachusetts Institute of Technology and the National Science Foundation. This Project is an outgrowth of the recommendation of the Conference that the National Science Foundation support the preparation of a handbook by NBS. The contents of the Handbook are being determined with the assistance of an Ad Hoc Committee on Tables appointed by the National Research Council, consisting of Philip M. Morse, Chairman, A. Erdelyi, Marion C. Gray, N. Metropolis, R. D. Richtmyer, J.B. Rosser, Henry C. Thacher, Jr., John Todd, C. B. Tompkins, and J. W. Tukey.

Status: NEW. A proposal outlining the complete volume was prepared and submitted to the sponsoring committee. The preliminary manuscript for chapter 6 on Gamma and Related Functions by P. Davis and for Chapter 3 on Fundamental Constants by D. Liepman have been prepared. The introductory text to chapter 17 on Statistical Tables by M. Zelen, and N. Severo is in process.

In the course of the preparation of chapter 6, the following new tables were computed: $\log \Gamma(n+\frac{1}{2})$, $\log \Gamma(n+\frac{1}{3})$, $\log \Gamma(n+\frac{2}{3})$, $n=0(1)100$; $\psi(x)$, $x=0(.005)1$; $\log \Gamma(n) - (n-\frac{1}{2}) \log n + n$, $n=1(1)100$, $\log n - \psi(n)$, $n=1(1)100$.

## 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.

### 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 1955 issue, page 12.

    Publications:
(1) Statistical investigation on the fatigue life of deep groove ball bearings.  J. Lieblein and M. Zelen.  Appeared: J. Res. NBS 57, 273-316 (Nov. 1956), RP2719.
(2) The weighted compounding of two probabilities from independent significance tests.  M. Zelen and L. Joel.  Submitted to a technical journal.

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.  M. Zelen has submitted a paper to a technical
journal entitled "The use of incomplete block designs for asymmetrical
factorial arrangements."  The paper contains methods for using the
balanced and group-divisible incomplete block designs for asymmetric
factorial experiments.
        W. S. Connor has begun a study of inequalities that restrict
the number of constraints in orthogonal arrays.

    Publications:
(1) Contributions on partially balanced incomplete block designs with
    two associate classes.  W. H. Clatworthy.  Appeared: NBS Applied
    Mathematics Series 47  (1956, U. S. Government Printing Office,
    Washington, D. C., 45¢).
(2) On the identity relationship for fractional replicates of the $2^n$
    series.  R. C. Burton and W. S. Connor.  Submitted to a technical
    journal.
(3) Fractional factorial experiment designs for factors at two levels.
    To appear as NBS Applied Mathematics Series 48.
(4) 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,
    Washington, D. C.
(5) 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, Washington,D.C.
(6) The analysis of covariance for incomplete block designs.  M. Zelen.
    To appear in Biometrics.
(7) Exact tests of significance for combining inter- and intra-block
    information. M. Zelen.  Submitted to a technical journal.
(8) The use of incomplete block designs for asymmetrical factorial
    arrangements. M. Zelen.  Submitted to a technical journal.


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

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

Status:  INACTIVE.  For status to date, see the July-Sept 1956
issue, page 15.


### 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:  INACTIVE.  For status to date, see July-Sept 1956 issue,
page 15.


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


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

Origin:  NBS                                             Authorized 3/23/56
Manager:  M. Zelen
Full task description:  Jan-Mar 1956 issue, p. 13

Status:  CONTINUED.  J. R. Rosenblatt is preparing a paper, "On
prediction of system performance from information on component performance,"
to be presented at the 1957 Western Joint Computer Conference,
"Techniques for Reliability."

# 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. A. Ghaffari is continuing a study concerning stability of solutions and existence of periodic solutions of second order non-linear ordinary differential equations of Cartwright-Littlewood type.

A theoretical analysis of the Cartesian diver balance is being completed by F. Chilton. Two equations have been derived. One gives the mass of an unknown object in terms of mass and density of the diver and the pressure applied to the system. To use the second expression it is not necessary to know the mass and density of the diver, only the mass and density of a standard weight. These expressions were developed for constant temperature where the bubble is a perfect gas obeying Boyle's law. Computations using representative values for the independent variables have been made. It was found for example that a glass diver weighing 1 mg could weigh an object of $10^{-10}$ gms. An analysis has been made for the magnitude of the error resulting from errors in the measurement of the independent parameters. From these it was ascertained that the most important experimental factor is temperature control.

Work has been completed by W. H. Pell on a graphical solution of the single degree of freedom vibration problem with arbitrary damping and restoring forces. A paper has been completed and accepted for publication. Additional work on the graphical solution of ordinary differential equations is now in progress.

For the geophysical problem of the static deformation of the earth under gravitational forces, the checking of the SEAC code is being continued by U. Hochstrasser. This analysis includes the case for earth tides, and in general, handles any distribution of earth surface densities which are representable by spherical harmonics of degree 3,4,5 or 6.

Publications:
(1) Entropy changes in rarefaction waves. R. F. Dressler. J. Res. NBS **57**, 265-271 (Nov. 1956), RP2718.
(2) A discussion of the paper "Design of corrugated diaphragms," by J. A. Haringx. R. F. Dressler. To appear in Transactions of the American Society of Mechanical Engineers.
(3) On the representation of a certain integral involving Bessel functions of hypergeometric series. P. Henrici. To appear in the Journal of

Mathematics and Physics.
(4) On the domain of regularity of generalized axially symmetric potentials.
P. Henrici.  To appear in the Proceedings of the American Mathematical
Society.
(5) The quotient-difference algorithm.  P. Henrici.  To appear in NBS
Applied Mathematics Series 49, "Further contributions to the solution
of simultaneous linear equations and the determination of eigenvalues."
(6) Graphical solution of the single degree of freedom vibration problem
with arbitrary damping and restoring forces.  W. H. Pell.  To appear
in the Journal of Applied Mechanics.
(7) 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.
(8) On the propagation of turbidity currents.  R. Stoneley.  To appear in
the Vening Meinesz Jubilee Volume.
(9) The attenuation of Rayleigh waves with depth in a medium with two
surface layers.  R. Stoneley and U. Hochstrasser.  To appear in the
Geophysical Supplement, Monthly Notices, Royal Astronomical Society.


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


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

        Status:  TERMINATED.


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.  W. H. Pell is engaged in a study of the
infinite solid elastic cone subjected to forces applied on its boundary.
Using the method of singular integrals of Kelvin, the displacements
for the case of a constant normal force applied along an axial circle are
being obtained.  These involve elliptic integrals of the first and second

kinds. A manuscript on this is in preparation. More complex
distributions of force along such a circle can be handled in a similar
way, but results obtained are so complicated algebraically as to be of
doubtful value for distributions, except those given by simple trigonometric
polynomials. Employing superposition, the solution obtained in this way
can be used, in principle, to obtain displacements and stresses due to a
finite band of force applied to the cone. However, the integrals involved
are quite complicated even for the axially symmetric case, and it seems
probable that it might be simpler to make use of the stress function
approach of Boussineq, Neuber, or Timpe, in a way analogous to the
recent work of Sternberg et al., for several problems on axially symmetric
bodies with axially symmetric surface loads or displacements.

The computations for all stress components, displacement
components, and resultant membrane forces and bending moments have been
completed by R. F. Dressler for a typical corrugated diaphragm shape over
a 9 to 1 range of thickness ratios. All these results have been transformed
into appropriate dimensionless quantities, and the complete data have
been put into graphical form for easy interpretation. As the thickness
ratio decreases, bending moments decrease but the local stresses producing
these moments nevertheless increase rapidly. All other stresses and
resultants increase more or less as various inverse powers of the thickness
ratio. The maximum stress magnification occurring in the thickest case
is 1000 times the applied pressure, and in the thinnest case reaches a
factor of 16,000. A paper presenting and interpreting these results
is in preparation.

The mathematical and computational work on the vibrating delta
wing problem has been completed for several aspect ratios and several
values of Poisson ratio, for the lowest mode. It has been determined
that a matrix of order 45 is sufficiently large for reasonable accuracy
in such problems, even when highly unsymmetric finite difference operators
must be used to express the free boundary conditions. It has been
decided not to extend the investigation to the determination of higher
modes because of the excessive machine time and resulting expense which
would be required. A manuscript has been prepared.

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
    electromagnetism. J. L. Synge. To appear in the Proceedings of the
    Eighth Symposium in Applied Mathematics of the American Mathematical
    Society, held at Chicago, Ill., April, 1956.
(3) Elastic waves in anisotropic media. J. L. Synge. Submitted to a
    technical journal.
(4) The torsion of a hollow square. J. L. Synge and W. F. Cahill.
    Submitted to a technical journal.

(5) The vibration of triangular wings.  R. F. Dressler.  In manuscript.
    Abstract available in the Proceedings of the Ninth International
    Congress on Mechanics, Brussels, September 1956.


## 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.  The extensive compilation of Fourier transforms
has been completed.  In the case of about 100 of the formulas,
normalization factors for the integrals have still to be determined;
these calculations are proceeding.


## 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.  J. M. Burgers and A. Ghaffari are undertaking
a study of the thrust produced by means of a steam jet.  The model under
consideration is a vessel moving under water with its inlet and exit
pressures equal to the ambient pressure in the surrounding water.  A
part of the water intake is converted into steam.  The mixture is
expelled as a jet directed backward to produce thrust.  The steam is
expanded so that entropy is transformed into velocity, and simultaneously
the steam is being condensed to water internally.  The enthalpy equation
gives the speed of the mixture.  The Mollier steam tables are employed
in this analysis to determine the velocity of the water-steam mixture.

     Publication:
(1) Condensation interfaces in two-phase flows.  P. Chiarulli and
    R. F. Dressler.  Submitted to a technical journal.  Abstract
    appeared in the Proceedings of the Ninth International Congress on
    Mechanics, Brussels, September 1956.

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.  The investigations concerning the propagation
of electromagnetic and acoustic pulses have been extended.  Expressions
for the diffracted field of a spherical wave, as well as a cylindrical
and plane wave, with arbitrary pulse function, on wedges, have been
found in the form of integral representations.  This broadens the work
reported in the July-September 1956 issue, and published as reported
below.

    Publication:
(1) On the propagation of pulses:  Part I.  Diffraction of pulses by
    wedges. F. Oberhettinger. Zeit. Phys. 146, 423-435 (1956).

## 5. MATHEMATICAL AND COMPUTATIONAL SERVICES

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.  A new approach to the phase determination problem is
  being coded.


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.  About 42 calculations for d-spacings for tetragonal,
  hexagonal, orthorhombic and monoclinic crystals were performed.  Also
  redetermination of unit cell constants by least squares fitting to
  measured d-spacings was carried out for about 45 crystals.


1102-40-5126/53-51    RADIATION DIFFUSION, III
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.  Data on the angular distribution from gun source
  radiation emissions have been obtained.  Additional values for coulomb
  scattering cross sections have been computed.
        Biasing techniques for greater statistical efficiency in the
  case of deep penetration of radiation are being investigated.  Codes
  incorporating both energy and spatial biasing have been written and
  preliminary results are being analyzed.
        A service routine (coco) which compiles and inserts changes in
  a code has been written and presented as Technical Memorandum 81.


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.  During the past quarter, 14 bid evaluation problems
  were solved for the Quartermaster Corps.

3711-60-0009/54-17    DEPOLYMERIZATION
Origin:  NBS, Section 7.6
·Manager:  U. Hochstrasser
Full task description:  Oct-Dec 1953 issue, p. 44
Status:  Completed.  Nine additional cases required by the sponsor for
  completing the study have been run and transmitted to the Section.


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:  Inactive.  For status to date, see Jan-Mar 1956 issue, p. 19.


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.  The work on thulium I has been completed.  The
  wavelengths of tantalum I have been converted to vacuum wave numbers.
  The spectrum has been searched with 35 wave number differences.  More
  work needs to be done on this spectrum.  The spectrum of hafnium I has
  been reduced to vacuum wave numbers.  This spectrum will be searched
  after classified lines have been removed.


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.


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:  Terminated.


3711-60-0009/55-68    CRYSTAL STRUCTURE CALCULATIONS
Origin:  NBS, Division 9
Manager:  R. Prosen (Div. 9)
Full task description:  Jan-Mar 1955 issue, p. 18
Status:  Continued.  Structure factors were computed for the following
  crystals: $M_{g2}B_2O_5$, $Ca_{10}(PO_4^{·})_6(OH)_2$, and $Zn_2B_2O_4$.  Code checking of the
  routine to calculate three-dimensional electron density maps has  been
  resumed.

3711-60-0009/55-75    PARAMETER OF THE DISPERSION EQUATION FOR OPTICAL GLASS
<u>Origin</u>:  NBS, Section 2.2
<u>Manager</u>:  R. Zucker
<u>Full task description</u>:  Jan-Mar 1955 issue, p. 20
<u>Status</u>:  Continued.  Table of $n_c$ (index of refraction) was computed for
  $AS_2S_3$ at 25°C.

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

for    $\lambda_1^2 = .0225,$                        $k_1 = 1.8983678,$

       $\lambda_2^2 = .0625,$                        $k_2 = 1.9222979,$

       $\lambda_3^2 = .1225,$                        $k_3 = 0.87651339,$

       $\lambda_4^2 = .2025,$                        $k_4 = 0.11887038,$

       $\lambda_5^2 = .750,$                         $k_5 = 0.95699034.$

The range of $\lambda$ was .56(.02)2(.2)12.  The constants $k_i$ were determined
previously by the method of least squares.  The table was checked and
submitted to sponsor.


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>:  Inactive.


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 computed for four thermometers
  under test.


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

1102-40-5126/55-113   REACTOR DESIGN
Origin:  Westinghouse Atomic Power Division
Sponsor:  Atomic Energy Commission
Manager:  U. Hochstrasser
Full task description:  Jan-Mar 1955 issue, p. 28
Status:  Continued.  Some trial runs with the code for the base reactor
   problem have been made.  Certain difficulties due to the changes in the
   code are being eliminated.


1102-40-5126/55-117    ATTENUATION OF PRESSURE PULSES OF FINITE AMPLITUDE
Origin:  NBS, Section 3.2
Sponsor:  Bureau of Aeronautics, U. S. Navy
Manager:  M. Paulsen
Full task description:  Apr-June 1955 issue, p. 18
Status:  Inactive.


1102-40-5126/55-118    THERMOMETER CALIBRATION, II
Origin and Sponsor:  NBS, Section 3.1
Manager:  B. G. Urban
Full task description:  Apr-June 1955 issue, p. 18
Status:  Inactive.  For status to date, see Jan-Mar 1956 issue, p. 22.


1102-40-5126/55-121    ELECTRON PENETRATION
Origin:  NBS, Section 4.8
Sponsor:  Atomic Energy Commission
Manager:  S. Peavy
Full task description:  Apr-June 1955 issue, p. 19
Status:  Continued.  The first run of the tables for the spatial moments
   of carbon, aluminum, and copper for the energy values 0.1, 0.2, 0.4, 0.7
   Mev and for three geometries have been made.


1102-40-5126/55-123    TEMPERATURE DISTRIBUTION
Origin and Sponsor:  NBS, Section 6.4
Manager:  W. F. Cahill
Full task description:  Apr-June 1955 issue, p. 19
Status:  Continued.  Two additional sets of computations were made, and
   the results were transmitted to the sponsor.


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:  Completed.  The results were transmitted to the sponsor.

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.  The table of $\varepsilon$ vs. d/h mentioned in the July-
   Sept 1956 issue, p. 27, has been continued.


3711-60-0009/56-131    CALCULATIONS IN OPTICS
Origin:  NBS, Section 2.2
Manager:  D. P. Feder (2.2)
Full task description:  July-Sept 1955 issue, p. 33
Status:  Completed.


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:  Inactive.


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:  Completed.  Results have been transmitted to sponsor.


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.  Computations are performed as the data are furnished
   by the sponsor.  At the present time the data as we receive it are
   inscribed on wire cartridges by the sponsor and are presumably correct
   and ready for SEAC.  The sponsor checks his own data and is solely
   responsible for the accuracy of the inscriptions.  Currently this is
   done using the peripheral equipment for SEAC located on Bureau grounds.
   In the future the sponsor expects to have the necessary teletype
   equipment to duplicate the SEAC peripheral equipment and thereby perform
   all data preparation.  Current estimates indicate that there will be 30
   problems a week, each of which will require approximately 20 minutes
   of SEAC time.

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:  Terminated.  The NORC codes were turned over to the sponsor for
  continued computation of trajectories.


1102-40-5126/56-162    STRESSES IN A WALL RESTING ON A FOOTING
Origin and Sponsor:  NBS, Section 10.1
Manager:  I. Stegun
Full task description:  Jan-Mar 1956 issue, p. 26
Status:  Continued.  The data for the solution of 100 simultaneous equations
  is being checked.


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.  Sensitivity to changes in parameters is being tested.


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:  Completed.  The following integrals were evaluated for given
  sets of $\beta$ and p, for $I(\xi)$, [confluent and Bessel]:

$$(1) \quad 3.438 \, \frac{\beta^{5/2}}{p} \int_0^\infty I \cdot \xi^2 \, e^{-\beta\xi} d\xi$$

$$(2) \quad \frac{1.329}{\beta^{5/2}} \cdot \frac{\int_0^\infty I^2 \, \xi^{5/2} \, e^{-\beta\xi} d\xi}{[\int_0^\infty I \, \xi^2 \, e^{-\beta\xi} d\xi]^2}$$

$$(3) \quad \frac{4.572}{p} \cdot \frac{\int_0^\infty I^2 \cdot \xi^{5/2} \, e^{-\beta\xi} d\xi}{\int_0^\infty I \cdot \xi^2 \, e^{-\beta\xi} d\xi}$$

$$(4) \quad \frac{2.091}{p^2} \left\{ \left[ \frac{\int_0^\infty I^2 \, \xi^{5/2} \, e^{-\beta\xi} d\xi}{\int_0^\infty I \cdot \xi^2 \, e^{-\beta\xi} d\xi} \right]^2 - \frac{\int_0^\infty I^3 \, \xi^3 \, e^{-\beta\xi} d\xi}{\int_0^\infty I \, \xi^2 \, e^{-\beta\xi} d\xi} \right\}$$

The results were submitted to the sponsor.


1102-40-5126/56-166     SCF-LCAO SOLUTION OF SOME HYDRIDES
Origin and Sponsor:  NBS, Section 5.9
Manager:  E. Haynsworth
Full task description:  Jan-Mar 1956 issue, p. 27
Status:  Inactive.


1102-40-5126/56-169     CRYSTAL FIELD EFFECTS FOR ATOMS
Origin and Sponsor:  NBS, Division 3
Manager:  I. Stegun
Full task description:  Jan-Mar 1956 issue, p. 28
Status:  Inactive.  For status to date, see Jan-Mar 1956 issue, p. 28.


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.  Several reruns were made using the code mentioned
   in the July-Sept 1956 issue, p. 30.


1102-40-5126/56-172     NUMERICAL EVALUATION OF SPECIAL INTEGRAL EXPRESSIONS
Origin and Sponsor:  Diamond Ordnance Fuze Laboratory, Department of the
                          Army
Manager:  L. Joel
Full task description:  Jan-Mar 1956 issue, p. 29
Status:  Inactive.


1102-40-5126/56-176     MODEL GOVERNMENT PAYROLL ON HIGH SPEED COMPUTERS
Origin and Sponsor:  NBS, Section 12.5
Manager:  G. H. Urban
Full task description:  Jan-Mar 1956 issue, p. 30
Status:  Inactive.


1102-40-5126/56-179     NORMAL PROPAGATION CONSTANT
Origin and Sponsor:  NBS, Section 82.10
Manager:  H. H. Howe (82.10)
Full task description:  Apr-June 1956 issue, p. 30
Status:  Re-activated.  A paper was presented at the meeting of the
   National Academy of Sciences, in Washington, D. C., on November 8,
   summarizing the results already obtained.  The title of the paper is
   "Modes of propagation of VLF radio waves, treating the ionosphere and the
   earth as a Lossy wave guide," by H. Howe and J. R. Wait.

Computations were made on the SEAC for additional combinations of values of the parameters H,K, G,L, for modes n = 0,1,2,3.  The method that had previously proved successful was used.  It involves two stages:  First, for fixed H,K,G,L (L being very small), trace in the c-plane a curve of real n, spotting the points where n is integral. Second, for fixed H,K,G,n (n being integral), vary L and determine c, using the results of the first stage as the starting point.

Using the two spherical-correction formulas given on page 31 of the April-June 1956 issue, and applying the same method, computations were made for a relatively small number of combinations of the parameters.

1102-40-5126/56-184    GAIN CALCULATIONS OF AN ITERATED TRANSISTOR AMPLIFIER
Origin and Sponsor:  Diamond Ordnance Fuze Laboratories, Department of
                        the Army
Manager:  E. Haynsworth
Full task description:  Apr-June 1956 issue, p. 32
Status:  Inactive.  For status to date, see July-Sept 1956 issue, p. 32.

1102-40-5126/56-186    MECHANICAL MEASUREMENTS OF GAGE BLOCKS
Origin and Sponsor:  NBS, Section 2.5
Manager:  S. Prusch
Full task description:  July-Sept 1956 issue, p. 33
Status:  Continued.  Data for three sets of gage blocks were processed
  for the sponsor.

1102-40-5126/56-187    RADAR SYSTEMS-SCINTILLATION AND RECEIVER NOISE
Origin and Sponsor:  Diamond Ordnance Fuze Laboratory, Department of the
                        Army
Manager:  B. S Prusch
Objective:  To calculate

$$N(\bar{\phi}) = \frac{\sum_{j=1}^{H} M[\bar{\bar{\phi}}(\phi_{oj})]}{H}$$

where

$$M[\bar{\bar{\phi}}(\bar{\phi}_{oj})] = \frac{e^{-c^2}}{2\pi a\ \sigma_\tau \sigma_T} + \frac{b\ e^{(b^2/4a^2)-c^2}}{4\sqrt{\pi}\ a^3\ \sigma_\tau \sigma_T}\ \mathrm{erf}(b/2a)$$

$$a^2 = \frac{\bar{\phi}^2}{2\ \sigma_\tau^2} + \frac{1}{2\ \sigma_T^2}$$

$$b^2 = \frac{\bar{\phi}\ \bar{\tau}}{\sigma_\tau^2} + \frac{\bar{\bar{T}}}{\sigma_T^2}$$

$$c^2 = \frac{\bar{\bar{\mathcal{T}}}^2}{2\,\sigma_{\mathcal{T}}^2} + \frac{\bar{T}^2}{2\,\sigma_T^2}$$

$$\bar{\mathcal{T}} = \sum_i \emptyset_i (N_o + AF_i x_o)$$

$$\bar{T} = \sum_i (N_o + AF_i x_o)$$

$$\sigma_{\mathcal{T}}^2 = \sum_i \emptyset_i^2 (N_o + AF_i x_o)^2$$

$$\sigma_T^2 = \sum_i (N_o + AF_i x_o)^2$$

$$A = \frac{G_o^2 \lambda^2 P}{(4\pi)^3 \gamma^4}$$

$$F_i = \frac{\sin\left(\frac{\pi d \emptyset_i}{\lambda}\right)}{\left(\frac{\pi d \emptyset_i}{\lambda}\right)^4}$$

$$\emptyset_i = \emptyset_o + i\,\Delta\emptyset$$

Values of $G_o$, $P, d, N_o, x_o$ and $\Delta\emptyset$ are given.

Background:  The Diamond Ordnance Fuze Laboratory is examining the track-
while-scan radar systems and is interested in the angular accuracy
obtainable by various methods.  In the above calculations, $N(\emptyset)$ is the
probable distribution error in the position of the target.  Preliminary
calculations for one of the methods had been made in which the effect
of scintillation and receiver noise was added to the signal, and which
was expected to be a function of range and radar parameters.  The
problem was communicated by J. M. Kirschner (DOFL).

Status:  Completed. (New).  Calculations were carried out for two values
of $\lambda$, nine values of $\emptyset_o$, and several values of $\gamma$.


1102-40-5126/56-192    NOISE MEASUREMENT
Origin and Sponsor:  NBS, Section 6.1
Manager:  W. F. Cahill
Objective:  To tabulate

$$f(r,z) = 10\,\log_{10}\emptyset$$

where

$$\emptyset = 1 + \frac{\sin 4\pi z}{4\pi z} + \frac{\sin 4\pi r}{4\pi r} + \frac{\sin 4\pi \sqrt{r^2 + z^2}}{4\pi \sqrt{r^2 + z^2}}$$

$$+ \frac{\sin 2\sqrt{2}\ \pi r}{\sqrt{2}\ \pi r} + \frac{\sin 4\pi \sqrt{r^2/2) + z^2}}{2\pi \sqrt{(r^2/2) + z^2}}$$

for $\qquad\qquad z = a(\Delta z)b, \quad r = c(\Delta r)d.$

Background: The function f(r,z) represents the intensity level in a reverberant sound field. This is of importance in using a reverberation chamber. The problem was transmitted by R. V. Waterhouse (6.1).

Status: New. The function f(r,z) has been tabulated for z = 0(.01)2.0, r = 0(.05)2.0, and the results were transmitted to the sponsor.


1102-40-5126/57-195    CONTINUED FRACTIONS
Origin and Sponsor: NBS, Section 11.3
Manager: R. Durrah
Full task description: July-Sept 1956 issue, p. 33
Status: Completed.   Results were transmitted to the sponsor


1102-40-5126/57-206    EXPECTED VALUES OF ORDER STATISTICS
Origin and Sponsor: NBS, Section 11.3
Manager: R. Durrah
Full task description: July-Sept 1956 issue, p. 34
Status: Continued. Checking of the codes mentioned in the July-Sept 1956 issue has been completed. Computations are now in process.


3711-60-0009/57-210    SOUND VELOCITY
Origin and Sponsor: NBS, Section 3.2
Manager: U. Hochstrasser
Full task description: July-Sept 1956 issue, p. 34
Status: Continued. The code for computing the velocity of sound has been checked out. Some changes are being incorporated into the existing orthonormalization code in order to facilitate its use for the necessary curve fitting.


1102-40-5126/57-211    METEOROLOGICAL DATA
Origin and Sponsor: Diamond Ordnance Fuze Laboratory, Department of the Army
Manager: P. O'Hara
Objective: To perform calculations required in studying the possibility of predicting the variation of air density as a function of height above sea level.

Background:  The data for this problem was collected by the Air Weather
   Service and the Weather Bureau at 15 stations located in various
   climatic regions of the world.  Temperature and altitude were recorded
   twice daily for each of 20 standard pressure surfaces at each station.
   The density of air can be computed from the known pressure and temperature.
Status:  New.  A sample calculation is being carried out using the data
   from one station.


1102-40-5126/57-215    COMPUTATION OF INTEGRALS INVOLVING BESSEL FUNCTIONS
Origin and Sponsor:  NBS, Section 6.1
Manager:  U. Hochstrasser
Full task description:  July-Sept 1956 issue, p. 35
Status:  Continued.  A table for $P(x,\theta)$ and $Q(x,\theta)$ has been computed and
   transmitted to the sponsor.  Since the formulae used for evaluating the
   integrals become increasingly inaccurate for large values of x, better
   approximation formulae are being incorporated into the code.


3711-60-0009/57-219    THERMAL PROPERTIES
Origin and Sponsor:  NBS, Section 3.2
Managers:  J. Cooper, D. Sumida
Objective:  To mechanize the computation of finding smooth values of the
   derivative of energy versus temperature, and several other relationships,
   by numerical integration.
      Calorimetry measurements give tabular values of energy
differences $\Delta Q$ versus temperature T.  From these initial data, curves of
the following quantities must be found:

      (1)  Q vs. T
      (2)  dQ/dT vs. T
      (3)  (dQ/dT)/T vs. T.


   This work will take into account the following conditions:
   (1) Each energy difference, $\Delta Q$, for the temperatures below
the triple-point temperature, $T_o$, must be corrected according to the
equation:

$$Q_n = -K \cdot \frac{T_n - T_{n-1}}{(1 - \frac{T_n}{T_o} \cdot \frac{T_{n-1}}{T_o} \cdot \frac{T_n T_{n-1}}{T_o^2})}$$

where K is a given constant; $T_{n-1}$, $T_n$ are the initial and final
temperatures for which each energy difference $\Delta Q$ exists.
      (2) The derivative data must be smoothed so that the first and
second differences of the derivatives are smooth and non-oscillating.
      (3) The smoothed derivative data are to be extrapolated to
zero temperature along a curve of the type $dQ/dT = \theta T^3$, where $\theta$ is an
arbitrary constant.

In addition, the following quantities are to be calculated:

$$(1) \quad \int_0^{T_0} dQ/dT \; dT$$

$$(2) \quad \int_0^{T_0} (dQ/dT)/T \quad dT = Y$$

$$(3) \quad \int_0^{T_0} Y \; dT$$

__Background__: The computations arise in connection with the determination
of specific heats of various compounds. The problem was communicated
by G. T. Furukawa (3.2).

__Status__: New.

1102-40-5126/57-221    BESSEL FUNCTIONS FOR COMPLEX ARGUMENTS

__Origin and Sponsor__:  Diamond Ordnance Fuze Laboratory, Department of the
                          Army

__Manager__: R. Zucker

__Objective__:  (1) To calculate the functions $j_n(z)$, $n_n(z)$, $h_n(z)$ and their
respective derivatives, where z is a complex argument:

$$\hat{j}_0(z) = \sin z \qquad\qquad \hat{n}_0(z) = -\cos z$$

$$\hat{j}_1(z) = \frac{\hat{j}_0(z)}{z} + \hat{n}_0(z) \qquad\qquad \hat{n}_1(z) = -\hat{j}_0(z) + \frac{\hat{n}_0(z)}{z}$$

$$\hat{h}_n = \hat{j}_n - i\,\hat{n}_n.$$

Recurrence relations used are the following, where $f = \hat{j}_n$ or $\hat{n}_n$:

$$(2n+1)\,\frac{f_n}{z} - f_{n-1} = f_{n+1}, \quad (n+1)\,\frac{f_n}{z} - f_{n+1} = f_n'.$$

(2) To calculate the expressions X and Y for given complex
values of $B_c$, $B_{oc}$, and k:

$$X = \cfrac{i}{k\,\hat{j}_n'(B_c)\cfrac{\hat{h}_n(B_{oc})}{\hat{h}_n'(B_{oc})} - \hat{j}_n(B_c)}$$

$$Y = \cfrac{i}{\hat{j}_n'(B_c) - k\,\hat{j}_n(B_c)\cfrac{\hat{h}_n'(B_{oc})}{\hat{h}_n(B_{oc})}}$$

Background:  The problem arises in the study of a loop antenna with a
   ferrite core.

Status:  New.  Difficulty was encountered in recurring the $\hat{j}$ function
   due to loss of significant figures.  Backward recursion was used to
   recur to $n=0$.  The following supposition was made:  Let $\bar{j}_{n+1}=0$, and
   let $\bar{j}_n$ be a small value.  At $n=0$, $\bar{j}_n$ was calculated from the given
   formula.  The values of $\hat{j}_n$ were then obtained by multiplying $\bar{j}_n$ by the
   normalizing factor $\hat{j}_o/\bar{j}_o$.
            The code has been checked out and cases are being computed
   on SEAC.


1102-40-5126/57-222    ROOTS OF POLYNOMIALS
Origin and Sponsor:  Naval Research Laboratory
Manager:  U. Hochstrasser
Objective:  To find the roots of a set of polynomials up to the
   eighteenth degree.
Background:  The polynomials arise in the computation of the intensities
   and polarization of neutrons incident on a slab containing polarized
   nuclei which scatter the neutrons resonantly.  The roots represent the
   zeros of a determinant, which arises when one develops the density
   of diffusely scattered neutrons in terms of spherical harmonics.  The
   coefficients of the polynomials are computed on NAREC.
            The problem was communicated by A. W. Sinz and A. Anderson of
   the Naval Research Laboratory.
Status:  New.  The roots of 56 polynomials have been computed using the
   code described in Technical Memorandum 66 and have been transmitted to
   the sponsor.


1102-40-5126/57-224    TRACK-WHILE-SCAN RADAR PROBLEM
Origin and Sponsor:  Diamond Ordnance Fuze Laboratories, Department of
                        the Army
Managers:  E. Haynsworth, P. J. Walsh
Objective:  To evaluate an integral of the following form

$$P*(\emptyset) = \frac{1}{a\pi} \int_0^{\infty} e^{-s^2} \int_{\infty}^{c+br} e^{-r^2} \, dr \, ds$$

   where c and b depend on $\emptyset$.  This function represents the probability
   that a zero crossing occurs when the center of the target makes an
   angle $\emptyset$ with the center of the beam.
Background:  The limit to the accuracy with which the angular position
   of a point target can be determined by a track-while-scan radar is set
   by stochastic processes such as target scintillation and receiver noise.
   The problem of determining the attainable accuracy of such a radar thus
   involves a statistical analysis of these uncorrelated perturbations.
   In this particular investigation a maximum likelihood technique is used

under the plausible assumptions that target scintillation obeys a
Rayleigh distribution law and that receiver noise is Gaussian.  The
target is supposedly fixed so that the probable error of a single
measurement is sought, and smoothing along the track of a moving
target is not involved.

      The problem was communicated by J. M. Kirschner (DOFL).

Status:  New.  The analysis and code for evaluating the above function
has been completed and the results have been submitted to the sponsor.
Further experimental computations are planned.


1102-40-5126/57-225    DAMAGE ASSESSMENT PROBLEM II
Origin and Sponsor:  Corps of Engineers, U. S. Army
Managers:  H. Bremer, W. G. Hall, L. S. Joel
Objective:  To advise and assist in the programming of the damage
assessment problem for the 1103A.
Background:  The computational analysis and programming aspects of the
damage assessment problem have been handled until the present in the
Bureau's Computation Laboratory for the Office of the Secretary of
Defense (see task 1104-40-5126/56-157, July-Sept 1956 issue, p. 28).
The problem is now being transferred to the newly formed Mathematical
Computation Division of the Corps of Engineers, U. S. Army.  The program
that was written at the Bureau was designed for the UNIVAC system,
whereas the current program undertaken by the Corps of Engineers is to
be written for the 1103A.  The Bureau has been requested to furnish
advisory services because of its recent experiences with the problem.

      Briefly, the damage assessment problem consists of simulating a
nuclear attack upon the country in terms of its resources and determining
the extent of damage to the resources.  The general objectives of the
1103A program will be identical with the UNIVAC program except for
certain refinements resulting from the earlier experience and from the
fact that a faster computer with a larger memory is available.

Status:  New.  The basic formulation of the problem that was used in the
UNIVAC program, those specifications for the 1103A that could be drawn
up at this time, and the flow charts have been turned over to the Corps
of Engineers.


3711-60-0009/57-227    CALCULATION OF ENTROPIES
Origin and Sponsor:  NBS, Section 3.3
Manager:  W. Nef
Objective:  To solve the equation

$$w^4 - (1/2)(4\Delta^2 + 5B^2)w^2 - (4/3)\Delta B^2 w + (\Delta^4 + (1/6)\Delta^2 B^2 + (9/16)B^4) = 0$$

for $\Delta = 0.1335$ and $B = 0.1(0.1)1.0$.  From the roots $w_1, \ldots, w_4$, to
compute the function

$$S/R = \frac{\partial}{\partial T}(T \log Z), \text{ where } Z = \sum_{k=1}^{4} e^{-w_k/T}$$

for T = 1.1, 1.15, 1.20, 1.25.  Furthermore, to compute S/R for the case
where the roots of the equation are

$$\pm\ 3B/2,\quad \delta \pm B/2 \quad (\ \delta = 0.267).$$

Here S represents entropy, R the universal gas constant, and S/R a
dimensionless quantity referring to one mole of chromic alum.
<u>Background</u>:  The problem arises in connection with the precise calculation
of entropies of thromic alums in magnetism and thermometry research
in section 3.3.  The problem was transmitted by R. P. Hudson.
<u>Status</u>:  Completed.  The results were transmitted to the sponsor.

# 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) Strength of glass: analysis of data, for M. J. Kerper,
Section 9.3.

 (2) Evaluation of waxes: analysis of data and methods for
improving precision of results, for W. W. Walton, Section 5.2.

 (3) Water turbulence: statistical analysis of data, for
G. C. Sherlin, Section 6.3.

 (4) Shelf life of transistors: design of an experiment for
determining aging characteristics, for G. Conrad, Section 1.6.

 (5) Strength of beams: fractional factorial designs for study
of various physical proportions, for S. Goodman, Section 6.4.

 (6) Statistical analyses were made on SEAC for H. Allen, Section
4.2; G. Conrad, Section 1.6; J. Mandel, Section 7.5; J. Hilsenrath,
Section 3.2; F. P. Knudsen, Section 9.1; R. E. Michaelis, Section 5.10;
and W. B. Mann, Section 4.9.

 W. S. Connor presented an in-hours course, "M144: Selected
Techniques of Statistical Analysis," as part of the in-hours program
of the NBS Graduate School. Enrollment: NBS, 9; DOFL, 15.


 Publications:

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

(2) Randomization and experimentation. W. J. Youden. To appear in the
  Annals of Mathematical Statistics.

(3) Statistics: Engineering viewpoint. W. J. Youden. To appear in the
  Journal of Engineering Education.

## 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.  An analysis of results from nine physical and
chemical tests on ship steel plates from current production is nearly
completed.  An incomplete block arrangement was used in the experiment,
so balanced that the variation of heats, ingots within a heat, and plates
within an ingot could be evaluated.

## 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.  W. S. Connor and C. Eisenhart visited the
regional offices of the U. S. Geological Survey, Denver Federal Center,
October 25-26, to confer with USGS staff on statistical aspects of their
geologic problems.  Advice was given on the following subjects:
       (1) Estimation of age of the uranium samples from isotope
abundance ratios, presented by Ralph Cannon, Geochemical Exploration Branch.
       (2) Correlation of various elements from semi-quantitative
spectrographic analyses on small drill core and mill pulp samples from
White Canyon District, Colorado Plateau, presented by Tom Fennell, Trace
Elements Planning and Coordinating Office.
       (3) Correlation and comparison of semiquantitative spectrographic
data on small suites of samples when many of the analyses are recorded
either as "zero", "trace", or simply "less than" some specified threshold
concentration, presented by Bob Jones, Geochemistry and Petrology Branch.
       (4) Distinguishing samples with an anomalous concentration of
an element from "background" samples, presented by Bert Lakin, Geochemical
Exploration Unit.
       (5) Presentation of semiquantitative spectrographic data on
selected suites of uraniferous coal samples, presented by Jim Vine and
Alan Merreweather, Trace Elements Planning and Coordinating Office.
       (6) The correlation of organic content with insoluble residue
in a series of limestone samples, presented by Bob Terriere, Fuels
Branch.
       (7) Design of sampling program for study of minor element
distribution in selected beds of the Pierre Shale, presented by

Harry Tourtelot, Fuels Branch.

Drs. Connor and Eisenhart recommended the use of Kendall's $\tau$ correlation coefficient in a number of the foregoing problems, and illustrated its use with data provided by the proposers of the problem. They also participated actively in the Clinic on Statistical Problems in Geology sponsored by the Committee on Statistics in Geology, Geologic Division, USGS, at the Denver Federal Center on October 26. Following the Clinic, Dr. Eisenhart and Dr. Connot addressed the Denver Pick and Hammer Club on "Uses and usefulness of Kendall's $\tau$" and "A stratified sampling plan with randomized spacing of samples within strata," respectively.

W. S. Connor conferred and corresponded with Dorothy Carroll (Geochemistry and Petrology Branch, Washington, D. C.) on her paper "Statistical study of heavy minerals in sands of the South River, Augusta County, Virginia." M. G. Natrella and J. R. Rosenblatt prepared some notes on the distribution and critical values of Kendall's $\tau$, for T. G. Lovering (Denver). C. Eisenhart, N. Severo, and V. Martinez began some theoretical and empirical studies of the effect of the logarithmic and anti-logarithmic transformations on true and observed values of the product-moment coefficient of correlation (r), for guidance in connection with the use of r in statistical analysis of semiquantitative spectrographic analyses of chemical constituents of rocks. C. Eisenhart, N. Severo, and V. Martinez also began an empirical investigation of methods for deriving confidence limits for "preferred directions," using data provided by F. G. Poole (Colorado Plateau District).


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. Part III, "Data Collection and Analysis (The Design of Experiments)" has been drafted. The section headings are "General Consideration," "Comparing the Performance of Several Items, Products or Processes," "Experiments in Which Several Factors are Studied Simultaneously," and "Experiments to Determine Optimum Conditions on Levels."

CATALOGUE OF FRACTIONAL REPLICATION DESIGNS
Task 1103-40-5147/57-213

Origin and Sponsor:  Bureau of Ships                    Authorized 8/30/56
Managers:  W. S. Connor, M. Zelen
Full task description:  July-Sept 1956 issue, p. 37

     Status:  CONTINUED.  Forty-one designs of the $3^n$ factorial series have been constructed and arranged in blocks of varying sizes.  The 1/3 fractional replications include 4, 5, 6, and 7 factors; the 1/9 replications include 6, 7, and 8 factors; the 1/27 replications include 7, 8, and 9 factors; the 1/81 replications include 8 and 9 factors; and the 1/243 replications include 9 and 10 factors.

     The designs are being checked and prepared for duplication, to appear with a suitable introduction as an NBS Report.

# APPLICATION

## OF

## NATIONAL BUREAU OF STANDARDS AUTOMATIC COMPUTER (SEAC)

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

| Task No. NBS: | Title | Code Checking | Productive Operation |
|---|---|---|---|
| 1104/55-55 | Research in numerical analysis | 1 | 9 |
| 5116/55-56 | Research in mathematical topics applicable to numerical analysis | | 1 |
| 5116/56-148 | Study of differential equations for nerve fiber excitation | 1 | 41 |
| 1110/47-2 | Tables of Coulomb wave functions | 2 | 12 |
| 1110/53-51 | Radiation diffusion | 9 | 60 |
| 5126/52-44 | Calculation for d-spacings | | 13 |
| 5126/53-29 | Dynamic behavior of aircraft structures | 12 | 4 |
| 5126/54-30 | Spectrometer analysis | 3 | 59 |
| 5126/55-68 | Crystal structure calculations | 5 | 13 |
| 0009/55-75 | Parameter of the dispersion equation for optical glass | | 2 |
| 5126/55-121 | Electron penetration | 3 | 17 |
| 5126/55-123 | Temperature distribution | 1 | 7 |
| 5126/55-127 | Vibration of a circular disc | 2 | 24 |
| 0009/56-131 | Ray tracing, II | 1 | 2 |
| 5126/56-139 | Internuclear potential for $H_3$ | | 1 |
| 5126/56-144 | Auto correlation | | 5 |
| 0009/56-160 | Mathematical subroutines | 8 | |
| 5126/56-162 | Stresses in a wall resting on a footing | | 4 |
| 5126/56-166 | SCF-LCAO solution of some hydrides | 1 | 9 |
| 5126/56-171 | Collision integrals used in transport theory | | 5 |
| 5126/56-179 | Normal propagation constant | 4 | 18 |
| 5126/56-192 | Noise measurement | | 8 |
| 5126/56-195 | Continued fractions | 8 | 39 |
| 5126/57-206 | Value order statistics | 9 | 16 |
| 0009/57-210 | Sound velocity | 7 | |
| 0009/57-215 | Computation of integrals involving Bessel functions | 2 | 2 |
| 5160/55-85 | Research in mathematical elasticity | | 10 |
| 5160/56-156 | Research in mathematical geophysics | 15 | 2 |
| 0002/52-1 | Statistical engineering | 11 | 8 |
| | Classified tasks | 17 | 183 |
| | Miscellaneous items | 10 | 24 |
| | Training | 44 | 56 |

| OTHER: | Title | Code Checking | Productive Operation |
|---|---|---|---|
| 5116/56-189 | Numerical experiments on potential theory | | 12 |
| 5126/53-45 | Application of game theory | 1 | 10 |
| 5126/54-13 | Award of procurement contracts for linear programming | | 98 |
| 5126/55-104 | "Fuze" problem | | 116 |
| 5126/55-113 | Reactor design | 3 | 13 |
| 5126/56-140 | Multiple correlation routines | | 15 |
| 5126/56-151 | Cross section measurements | | 23 |
| 5126/56-163 | Nuclear scattering | 1 | 13 |
| 5126/56-165 | Integral for scattering functions | | 27 |
| 5126/56-184 | Transistor amplifier | | 3 |
| 5126/57-216 | Handbook for computers | 9 | 2 |
| 5126/57-221 | Complex arguments for Bessel functions | 3 | 3 |
| 5126/57-222 | Roots of polynomials | 5 | 14 |
| 5126/57-224 | Track-while-scan radar problem | 10 | 2 |
| 1115/55-57 | Research in mathematical physics and related fields | 1 | |

# 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.

## Applied Mathematics Colloquium Series

LERAY, J. (College of France, and Institute for Advanced Study). The
    equations of hydrodynamics. November 30.

## Computation Laboratory Lecture Series

WEGSTEIN, J. Programming for the IBM 704.

## Statistical Engineering Seminar

WILLIAMS, E. J. (Commonwealth Scientific and Industrial Research Organization,
    South Melbourne, Australia). Statistics in Australia. October 29.

WOLD, H.O.A. (University of Uppsala, Uppsala, Sweden). Statistics in
    Sweden. December 6.

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

CANNON, E. W. Operating a Government computing center. Presented at an
    IBM Seminar on Research Computing for Federal Government Executives,
    Washington, D. C., October 24.

CONNOR, W. S. Experiences with incomplete block designs: Examples.
    Presented at a Symposium on the Design of Industrial Experiments,
    held by the Institute of Statistics, University of North Carolina,
    and the United States Air Force, Raleigh, N.C., November 6.

EISENHART, C.   (1) Statistical engineering at the National Bureau of
        Standards.   Presented at a Colloquium at the Mineral Industries
        Experiment Station, Pennsylvania State College, State College,
        Pa., November 30.   (2) Some canons of sound experimentation.
        Presented before the Penn State Chapter, American Statistical
        Association, State College, Pa., November 30.

MARCUS, M.   Convex functions of quadratic forms.   Presented at the
        meeting of the American Mathematical Society, held in Cambridge,
        Mass., October 27.

PELL, W. H.   Graphical solutions of ordinary differential equations.
        Presented before the Sigma Pi Sigma Chapter, Howard University,
        Washington, D. C., December 18.

TAUSSKY-TODD, O.   Application of a quaternion to the representation of
        a binary quadratic form as a sum of four squares.   Presented at
        the meeting of the American Mathematical Society held in
        Rochester, N. Y., December 27-29.

TODD, J.   (1) Computational problems concerning the Hilbert matrix.
        (2) Mathematicians and computers.   Presented at the Montreal
        Mathematical Colloquium, held at McGill University, Montreal,
        Canada, November 28-29.

YOUDEN, W. J.   (1) Getting the most out of your experiments.   Presented
        at a meeting held by the Reactor Development Division, Combustion
        Engineering, Inc., in conjunction with the Department of the Navy
        at Windsor, Connecticut, October 5.   (2) Randomization and
        experimentation.   Presented at a seminar of the Statistical
        Laboratory, Iowa State College, Ames, Iowa, October 10, at a
        seminar of the Department of Mathematical Statistics, Columbia
        University, New York, November 28; and also presented at a meeting
        of Sigma Pi Sigma, Howard University, Washington, D. C., November
        29.   (3) Experimental designs.   Presented before the Minneapolis
        Chapter of the American Society for Quality Control, Minneapolis,
        Minnesota, October 11.   (4) Problems of an experimenter.
        Presented before the Science Club, Northwestern High School,
        College Park, Maryland, October 26.   (5) Design of experiments
        in physical sciences.   Given at a Symposium on the Design of
        Industrial Experiments, held by the Institute of Statistics,
        University of North Carolina, and the United States Air Force,
        in Raleigh, North Carolina, November 5.   (6) The gun problem:
        Statistics--engineering viewpoint.   Presented at Picatinny Arsenal,
        Dover, New Jersey, November 21.   (7) Dice, data, and deductions.
        Presented before the Mathematics Club, Calvin Coolidge High School,
        Washington, D. C., December 3.

# Publication Activities

1. PUBLICATIONS THAT APPEARED DURING THE QUARTER

1.3 Technical Papers

    (1) Some algebraic number theory estimates based on the Dedekind
eta-function. H. Cohn. Amer. J. Math. **78**, 791-796 (Oct. 1956).

    (2) Entropy changes in rarefaction waves. R. F. Dressler. J. Res.
NBS **57**, 265-271 (Nov. 1956), RP2718.

    (3) Unimodular matrices of order two which commute. K. Goldberg.
J. Wash. Acad. Sci. **46**, 337-338 (1956).

    (4) Statistical investigation of the fatigue life of deep groove
ball bearings. J. Lieblein and M. Zelen. J. Res. NBS **57**, 273-316
(Nov. 1956), RP2719.

    (5) On the propagation of electromagnetic and acoustic pulses. Part I:
Diffraction of pulses by wedges. F. Oberhettinger. Zeit. Phys.
**146**, 423-435 (1956).

    The following papers appeared in Annals of Mathematics Study 38,
"Papers on linear inequalities and related systems" (Princeton
University Press, Princeton, N. J., 1956):

    (6) Dilworth's theorem on partially ordered sets. G. B. Dantzig
(RAND) and A. J. Hoffman. Pages 207-214.

    (7) On systems of linear inequalities. K. Fan. Pages 99-156.

    (8) Integral boundary points of convex polyhedra. A. J. Hoffman
and J. B. Kruskal (Princeton University). Pages 223-246.

    (9) On systems of distinct representatives. A. J. Hoffman and
H. W. Kuhn (Bryn Mawr College). Pages 199-206.

1.5 Miscellaneous items

    (1) Contributions on partially balanced incomplete block designs with
two associate classes. W. H. Clatworthy. NBS Applied Mathematics
Series 47. Available from U. S. Government Printing Office,
Washington 25, D. C., 45 cents.

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

2.1 Mathematical Tables

(1) Tables of the bivariate normal distribution function and related functions. To appear as NBS Applied Mathematics Series 50.

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. To appear as NBS Applied Mathematics Series 48.

2.3 Technical Papers

(1) A survey of Lyapunov's second method. H. Antosiewicz. To appear in Annals of Mathematics Studies.

(2) On the identity relationship for fractional replicates of the $2^n$ series. R. C. Burton and W. S. Connor. Submitted to a technical journal.

(3) Some examples of the use of high speed computers in statistics. J. Cameron. To appear in the Proceedings of the Office of Ordnance Research Conference on Designs of Experiments in Army Research, Development and Testing, Washington, D. C., October 1955.

(4) Condensation interfaces in two-phase flows. P. Chiarulli and R. F. Dressler. Submitted to a technical journal.

(5) A computation of cyclic cubic units. H. Cohn and S. Gorn (Moore School of Engineering). To appear in the Journal of Research, NBS.

(6) Computation of the transfinite diameter of two collinear line segments. P. Davis. To appear in the Journal of Research, NBS.

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

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

(9) A discussion of "Design of corrugated diaphragms" by J. A. Haringx. R. F. Dressler. To appear in the Transactions of the American Society of Mechanical Engineers.

(10) Systems of inequalities involving convex functions. Ky Fan,
     I. Glicksburg (University of Notre Dame), and A. J. Hoffman.
     To appear in the Proceedings of the American Mathematical Society.

(11) Estimation of frequencies of thin elastic plates with free
     edges. H. Fujita, T. Kato, Y. Nakata (University of Tokyo),
     and M. Newman. To appear in the Journal of Research, NBS.

(12) Pairs of matrices of order two which generate free groups.
     K. Goldberg and M. Newman. To appear in the Illinois Journal
     of Mathematics.

(13) Note on bounds for certain determinants. E. Haynsworth. Submitted
     to a technical journal.

(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. P. Henrici. To appear in
     the Journal of Mathematics and Physics.

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

(17) On the Hilbert matrix. T. Kato. To appear in the Proceedings
     of the American Mathematical Society.

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

(19) On a determinantal inequality. M. Marcus. Submitted to a
     technical journal.

(20) Some inequalities for quadratic forms and eigenvalues. M. Marcus.
     Submitted to a technical journal.

(21) Some extreme value results for indefinite Hermitian matrices.
     M. Marcus, B. N. Moyles and R. Westwick(University of British
     Columbia). Submitted to a technical journal.

(22) A note on symmetric functions of eigenvalues. M. Marcus and
     R. Thompson (University of British Columbia). To appear in the
     Duke Journal of Mathematics.

(23) An inclusion theorem for modular groups.  M. Newman.  To appear in the Proceedings of the American Mathematical Society.

(24) Construction and application of a class of modular functions. M. Newman.  To appear in the Proceedings of the London Mathematical Society.

(25) Some theorems about $P_r(n)$.  M. Newman.  To appear in the Canadian Journal of Mathematics.

(26) Classes of positive definite unimodular circulants.  M. Newman and O. Taussky.  To appear in the Canadian Journal of Mathematics.

(27) The representations of a quadratic form as a sum of four squares. G. Pall (Illinois Institute of Technology) and O. Taussky. Submitted to a technical journal.

(28) Graphical solution of the single degree of freedom vibration problem with arbitrary damping and restoring forces.  W. H. Pell. To appear in the Journal of Applied Mechanics.

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

(30) Generation of Bessel functions on high speed computers.  I. Stegun and M. Abramowitz.  Submitted to a technical journal.

(31) Pitfalls in computation.  I. A. Stegun and M. Abramowitz.  To appear in the Journal of the Society for Industrial and Applied Mathematics.

(32) The transmission of Rayleigh waves across an ocean floor with two surface layers.  R. Stoneley.  To appear in the Bulletin of the Seismological Society of America.

(33) The attenuation of Rayleigh waves with depth in a medium with two surface layers.  R. Stoneley and U. Hochstrasser.  To appear in the Geophysical Supplement, Monthly Notices, Royal Astronomical Society.

(34) Elastic waves in anistropic media.  J. L. Synge.  Submitted to a technical journal.

(35) Stationary principles for forced vibrations in elasticity and electromagnetism.  J. L. Synge.  To appear in the Proceedings of the Eighth Symposium in Applied Mathematics held by the American Mathematical Society, Chicago, Ill., April 1956.

(36) The torsion of a hollow square.  J. L. Synge and W. F. Cahill.
     Submitted to a technical journal.

(37) Classes of matrices.  O. Taussky.  To appear in the Illinois
     Journal of Mathematics.

(38) Commutativity in finite matrices.  O. Taussky.  To appear in the
     American Mathematical Monthly.

(39) Some computational problems concerning integral matrices.
     O. Taussky.  To appear in the 1956 Meeting of the Italian Society
     for the Advancement of Science, held in Sicily.

(40) Commuting bilinear transformations and matrices.  O. Taussky.
     and J. Todd.  To appear in the Journal of the Washington Academy
     of Science.

(41) 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.

(42) Computational problems concerning the Hilbert matrix.  J. Todd.
     To appear in the Proceedings of the 1956 Meeting of the Italian
     Society for the Advancement of Science, held in Sicily.

(43) Automatic coding principles.  J. Wegstein.  To appear in the
     Proceedings of a Symposium on Advanced Programming Methods for
     Digital Computers held by the Office of Naval Research, Washington,
     D.C., June 1956.

(44) Investigations of the properties of corrugated diaphragms.
     W. A. Wildhack (NBS Office of Basic Instrumentation), R. F. Dressler,
     and E. C. Lloy  (NBS Mechanics Division).  To appear in the
     Transactions of the American Society of Mechanical Engineers.

(45) Design of experiments in research and development.  W. J. Youden.
     To appear in the Proceedings of the Office of Ordnance Research
     Conference on Design of Experiments in Army Research, Development,
     and Testing, Washington, D. C., October 1955.

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

(47) Randomization and experimentation.  W. J. Youden.  To appear in
     the Annals of Mathematical Statistics.

(48) Statistics--Engineering viewpoint. W. J. Youden. To appear in the Journal of Engineering Education.

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

(50) The analysis of covariance for incomplete block designs. M. Zelen. To appear in Biometrics.

(51) The weighted compounding of two probabilities from independent significance tests. M. Zelen and L. S. Joel. Submitted to a technical journal.

(52) The use of incomplete block designs for asymmetrical factorial arrangements. M. Zelen. Submitted to a technical journal.

## 2.5 Miscellaneous

(1) Further contributions to the solution of simultaneous linear equations and the determination of eigenvalues. To appear as Applied Mathematics Series 49.

# 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.

## Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

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.