PROJECTS and PUBLICATIONS
of the
APPLIED MATHEMATICS DIVISION
A Quarterly Report
January through March 1959

FOR OFFICIAL DISTRIBUTION

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

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

Inquiries regarding the Bureau's reports should be addressed to the Office of Technical Information, National Bureau of Standards, Washington 25, D. C.
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IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
APPLIED MATHEMATICS DIVISION

January 1 through March 31, 1959

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Abolghassem Ghaffari, Ph.D. Chan Mou Tchen, Ph.D. Marie E. Yudowitch, B.S.**

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under contract with The American University

NUMERICAL ANALYSIS NUMERICAL COMPUTATION MATHEMATICAL PHYSICS

A. M. Ostrowski, Ph.D. Walter Gautschi, Ph.D. J. M. Burgers, Ph.D.**
Andreas Schof Y. M. Yevdjevich, D.Sc.

PARTICIPANTS IN NUMERICAL ANALYSIS TRAINING PROGRAM
under the sponsorship of the National Science Foundation

Richard V. Andree, Ph.D. Robert T. Gregory, Ph.D. E. P. Miles, Jr., Ph.D.
Truman A. Botts, Ph.D. Ralph E. Lee, Ph.D. Bill C. Moore, Ph.D.
G. Cleaves Byers, Ph.D. Leroy F. Meyers, Ph.D. Jack D. Munn, M.A.

*On leave of absence **Part time
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Status of Projects

March 31, 1959

1. NUMERICAL ANALYSIS

RESEARCH IN NUMERICAL ANALYSIS AND RELATED FIELDS
Task 1101-12-1104/55-55

Origin: NBS
Manager: P. Davis
Full task description: July-Sept 1954 issue, p. 1

Status: CONTINUED. W. Rheinboldt continued his comparative studies of the different iteration methods in functional analysis and their application to numerical analysis. He also continued the series of seminar lectures on functional analysis to members of the division staff. In these lectures the general theory of Newton's method for operator equations in Banach spaces was presented.

A. J. Goldman has determined the range of the real parameter $P$ for which all zeros of $z^{n+1} - z^n + P$ are interior to the unit circle. The solution is $0 < P < 2 \sin(n/(4n+2))$. The problem arose in examining the radius of convergence of a generating function.

N. Bazley has completed a note describing the method of intermediate problems for finding lower bounds to the eigenvalues of self-adjoint operators. This note will appear in a technical publication. Numerical bounds are given for the $E(1^1S)$ and $E(2^1S)$ energy levels of the helium atom. Convergence of the lower bounds to the true eigenvalues has been established when the inverse operators are completely continuous.

Numerical calculations of Markov chains with a large number of states have been carried out by P. Davis and N. Bazley. It should be emphasized that even if the matrix of transition probabilities has large order numerical solution via matrix powering is feasible when most of the matrix elements vanish. A "sparse" Markov chain of order 100 has been programmed for the 704 and a number of its parameters obtained. A Monte Carlo solution will be programmed and compared with these results.

E. Haynsworth has completed the paper "Reduction Formulae for Partitioned Matrices" and has submitted it to a technical journal. A second paper, "Application of a Theorem on Partitioned Matrices," is in manuscript form.

H. F. Weinberger solved the problem of bounding a function in terms of its values at $N$ equally spaced points and the square integral of its $k$th derivative was solved by interpolation with a function which is piecewise a polynomial of degree $2k-1$ with discontinuities in its $(2k-1)$th
This interpolation problem is reduced to the solution of a Dirichlet boundary value problem for a finite difference equation of order 2k. In this way the bounds can be obtained in terms of N by inverting only $k \times k$ matrices. This is important when $k$ is relatively small while $N$ is large.

Publications:
(7) On the relations between summation methods and integral transforms. W. Greub. In manuscript.
(13) Linear differential equations of the second order with large parameter. F. W. J. Olver. Submitted to a technical journal.
Status: CONTINUED. K. Goldberg has developed a formula for the expected value of the nth block in a flow of random data, with a block defined as a monotonically increasing sequence. In the limit, it is a polynomial of degree n in \( e = 2.71828 \ldots \) which closely approximates 2.

K. Goldberg has continued his investigation of gaps between values of a given function which are relatively prime to the first n primes. If the function is \( x^2 + 1 \) and \( n \leq 19 \), the maximum gap is less than the nth prime. If this is generally true, then \( x^2 + 1 \) represents an infinity of primes.

K. Goldberg has continued his investigation of algebras with an incidence matrix basis, with E. C. Dade.

M. Newman is preparing a manuscript on congruence properties of the coefficients of modular forms. Work on polynomial bases for classes of automorphic forms is continuing. Certain questions of structure of modular subgroups are being investigated.

In connection with the training course, a set of notes on matrix computation has been prepared by M. Newman. These will ultimately appear in the book on the lectures presented in Numerical Analysis Program I (1957) under preparation by J. Todd. The seminar on Vinogradov's methods is continuing; the introductory matter was concluded.

Publications:


(3) Incidence algebras. E. C. Dade and K. Goldberg. Submitted to a technical journal.


(6) Some combinatorial lemmas. K. Goldberg. In manuscript.


(15) A quantitative formulation of Sylvester's law of inertia. A. Ostrowski. Submitted to a technical journal.


(20) The minimum of a certain linear form. K. Goldberg. Submitted to a technical journal.


Status of Projects

STUDY OF DIFFERENTIAL EQUATIONS FOR NERVE EXCITATION
Task 1101-12-5116/56-148

Origin and Sponsor: National Institutes of Health
Manager: W. Gautschi (11.2)
Full task description: July-Sept 1955 issue, p. 7

Status: CONTINUED. Computations have been resumed for both the one- and the two-dimensional cases,—the former in a slightly modified form. Results are being transmitted to the sponsor.

TRAINING PROGRAM IN NUMERICAL ANALYSIS, II
Task 1101-40-5114/57-237

Origin and Sponsor: National Science Foundation
Manager: P. Davis
Full task description: Jan-Mar 1957 issue, p. 5

Status: REACTIVATED. The first two weeks of the program were devoted to an introduction to programming for automatic computation. Although the training program is not primarily a coding course, all participants have prepared and run simple test problems on the 704. The basis of the formal teaching, given by M. Newman, was a discussion of a complex of problems which illustrated various topics in numerical analysis and programming. This set of problems could readily be adapted for solution on any type of digital computer.

The second phase of the program will be devoted to surveys of particular chapters in numerical analysis. It will continue for about thirteen weeks. To date the following topics have been covered:

- Linear Equations
- Nonlinear Equations
- Matrix Computation
- Interpolation and Approximation
- Ordinary Differential Equations
- Elliptic Partial Differential Equations
- Monte Carlo Methods
- Bounds for Eigenvalues

In addition to these surveys, individual or shorter courses of lectures have been given by E. W. Cannon, I. Stegun, R. J. Arms, J. Wegstein, S. Gorn (Univ. of Pa.), A. Brauer (U. of N.C.), M. Hall (Ohio State), F. Alt, A. Grad (N.S.F.), and J. Pasta (A.E.C.).

Each participant has chosen a significant computation problem and is in process of preparing a code for it. The participants, and their institutions, are:

R. V. Andree, The University of Oklahoma
T. A. Botts, University of Virginia
G. Cleaves Byers, Michigan College of Mining and Technology
Status of Projects

R. T. Gregory, University of Texas
R. E. Lee, The University of Missouri
L. F. Meyers, The Ohio State University
E. P. Miles, Jr., The Florida State University
B. C. Moore, The Agriculture and Mechanical College of Texas
J. D. Munn, Mississippi Southern College
2. MATHEMATICAL TABLES AND PROGRAMMING RESEARCH

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

Origin: NBS
Manager: I. A. Stegun
Full task description: Apr-June 1949 issue, p. 45
Status: INACTIVE.

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

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

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

Origin: NBS
Manager: I. A. Stegun
Full task description: July-Sept 1951 issue, p. 41
Status: INACTIVE.

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

Origin: NBS
Manager: D. Liepmann
Full task description: Oct-Dec 1951 issue, p. 38
Status: INACTIVE.
Status of Projects

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

Origin: NBS  
Managers: M. Paulsen, P. O'Hara  
Authorized 2/12/52

Full task description: Jan-Mar 1952 issue, p. 46

Status: INACTIVE. For status to date, see Jan-Mar 1958 issue, p.8.

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

Origin: NBS  
Manager: J. Wegstein

Authorized 9/29/54

Full task description: July-Sept 1954 issue, p. 11

Status: CONTINUED. A program, BS LIST, was prepared by G. Galler for distribution to the SHARE organization. This program causes the 704 computer to read absolute or relocatable binary program cards and print them on-line or off-line in symbolic language.

Experiments were begun on a general purpose table generating program for inclusion in the Black Box Computer. A side product was the preparation of tables from data obtained in the analysis of watch jewel performance.

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

Origin: NBS  
Managers: Staff  
Authorized 9/30/55

Full task description: July-Sept 1955 issue, p. 13

Status: INACTIVE.

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

Origin and Sponsor: National Science Foundation  
Manager: I. A. Stegun  
Authorized 12/27/56

Full task description: Oct-Dec 1956 issue, p. 10

Status: CONTINUED. The textual material for Chapters 9,10,11 (Bessel Functions of Integral Order, Bessel Functions of Fractional Order, Integrals of Bessel Functions), Chapter 25 (Numerical Interpolation, Differentiation, and Integration), and Chapter 19 (Parabolic Cylinder Functions) has been distributed for comments. The manuscripts of the tables for Chapters 9,10 and 11 have been completed and are under way for Chapters 25 and 19. Chapter 15 (Hypergeometric Functions), Chapter 22(Orthogonal Polynomials), Chapter 27(Miscellaneous Functions), and Chapter 28(Scales of Notation) are being prepared for distribution.
3. PROBABILITY AND MATHEMATICAL STATISTICS

MISCELLANEOUS STUDIES IN PROBABILITY AND STATISTICS

Task 1103-12-1107/51-2

Origin: NBS
Manager: C. Eisenhart
Full task description: July-Sept 1950 issue, p. 58

Status: CONTINUED. N. C. Severo presented a paper entitled "Mathematical problems associated with measurements made by matching with known standards" at the Eastern Regional meetings of the Institute of Mathematical Statistics held in Pittsburgh March 19-21. The paper, which is a joint effort by W. S. Connor and N. C. Severo, concerned the evaluation of several integrals by means of appropriate use of the convolution formula.

References and certain other material from the abstract cards for the Bibliography of Statistical Literature (see Jan-Mar 1957 issue, p.14, for description) have been entered on punched cards and listings were made by subject classification. Addition of titles and other pertinent information is in progress.

Publications:

STUDIES IN THE MATHEMATICS OF EXPERIMENT DESIGN

Task 1103-12-1107/53-1

Origin: NBS
Manager: W. S. Connor
Full task description: Oct-Dec 1952 issue, p. 60

Status: INACTIVE.

Publication:
Status of Projects

STUDY OF NON-PARAMETRIC STATISTICAL TECHNIQUES
Task 1103-12-1107/56-170

Origin: NBS
Manager: M. Zelen, Joan R. Rosenblatt
Full task description: Oct-Dec 1955 issue, p. 14

Status: CONTINUED. J. R. Rosenblatt completed the manuscript of a paper, "On the power of some rank order two-sample tests."

Publication:
(1) On the power of some rank order two-sample tests. J. R. Rosenblatt. Submitted for publication.

MEASUREMENT OF RELIABILITY
Task 1103-12-1130/56-182

Origin: NBS
Manager: M. Zelen
Full task description: Jan-Mar 1956 issue, p. 13


M. Zelen completed a manuscript entitled, "Factorial experiments in life testing". This paper deals, in part, with an investigation of the robustness of proposed procedures for analyzing life test data.

Publications:
(2) Analysis of two-factor classifications with respect to life tests. M. Zelen. Submitted for publication.
(3) Factorial experiments in life testing. M. Zelen. Submitted to a technical journal.
FRACTIONAL FACTORIALS FOR THE MIXED SERIES
Task 1103-12-5148/58-291

Origin and Sponsor: Bureau of Ships
Managers: W. S. Connor, M. Zelen
Full task description: July-Sept 1957 issue, p. 43

Status: CONTINUED. Four activities are in progress:
(1) the electronic computer is being used to generate fractional replicates of the $3^n$ which will be suitably adjoined to fractional replicates of the $2^m$ to produce the mixed fractionals;
(2) these fractional replicates of the $2^m$ are being generated manually;
(3) certain small matrices needed for the analysis of the mixed fractionals are being inverted manually; and
(4) a code is being written which will enable the electronic computer to produce the normal equations for the designs, to be used to check equations already derived.

Publications:
(1) Construction of fractional factorial designs of the mixed $2^m3^n$ series. W. S. Connor. Submitted for publication.
4. MATHEMATICAL PHYSICS

RESEARCH IN MATHEMATICAL PHYSICS AND RELATED FIELDS
Task 1104-12-1115/55-57

Origin: NBS
Manager: W. H. Pell
Full task description: July-Sept 1954 issue, p. 27

Status: CONTINUED. C. M. Tchen has continued his work on the statistical approach to plasma dynamics. Emphasis is given to the relation between the microscopic and macroscopic description of a plasma. In connection with an NBS-wide proposed program for research in plasma dynamics, Dr. Tchen has prepared a survey and an outline of specific problems in plasma dynamics and magnetohydrodynamics as a plan of research for such a program. Proposed for investigation are some aspects of the general foundations of plasma dynamics, including the derivation of general kinetic equations for a plasma. Also to be investigated are transport properties and collective behavior of plasmas, such as conductivity and diffusion, radiation phenomena, various types of plasma waves, and other magnetohydrodynamical and plasma problems encountered in astrophysics, geophysics, and thermonuclear research.

The checking of page proofs of the paper "Diffusion of Particles in Turbulent Flow", by C. 'M. Tchen, to appear in the Proceedings of the Symposium on Atmospheric Diffusion has been completed.

The statistical analysis of the annual flows of rivers for Y. Yevdjevich's study of the fluctuation of river flows is essentially finished. The similar analysis for monthly flows is in progress. A paper entitled "Fluctuation of Wet and Dry Years of River Flow" is in preparation. A report entitled "The Error in the Computed Mean River Flow: Applied Statistics in Hydrology" is also being written. This study was considered necessary as a result of the analysis of the fluctuations referred to above. It is being prepared by Y. Yevdjevich in collaboration with Dr. Nicholas Matelas, Hydraulic Engineer, U. S. Geologic Survey, Water Resources Division. Some computations will be done on the Datatron in the Geologic Survey.

A. Ghaffari has continued his investigation of Rayleigh's equation (see Oct-Dec 1958 issue, p. 11). To describe the complete system of paths on the unit sphere it was first necessary to determine the nature of the critical points, and it was found that there are four, in two antipodal pairs, (0,±1,0), (+1,0,0) on the equator z = 0. The behavior of the paths on the unit sphere is governed by the homogeneous equation
z[μ(-yz^2 + \frac{1}{3}y^3) + xz^2]dx + yz^3dy

= [y^2z + x(xz^2 + μ(-yz^2 + \frac{1}{3}y^3))]dz.

It is found that the point (0,1,0) is the simplest type of node which is unstable, i.e., paths emanate from the node in every direction; similarly for its antipodal associate. In the phase plane the curves tending to infinity in the direction of the y-axis will have vertical asymptotes. It is shown similarly that the point (1,0,0) and its associate are critical points of higher order which behave like an ordinary saddle point: paths tending to the saddle point are tangent to one another.

Publications:
(1) Rotational properties of two-dimensional lattices. J. P. Vinti. Submitted to a technical journal.

RESEARCH IN CONTINUUM MECHANICS
Task 1104-12-5160/55-85

Origin: NBS
Sponsor: Office of Scientific Research, ARDC, USAF.
Manager: W. H. Pell
Full task description: Oct-Dec 1954 issue, p. 30

Status: CONTINUED. C. M. Tchen has continued his study of statistical plasma dynamics with the analysis centering on the kinetic equation. In particular, the structure of the correlation function is under scrutiny. Since the kinetic equation determines the distribution function of a single particle, a similar approach, based on the hierarchy equations, can lead to the determination of the correlation function for a plasma in nonequilibrium.

C. M. Tchen presented an invited lecture on "Recent Development of Statistical Plasma Dynamics" at the Magnetohydrodynamics Seminar at the Rensselaer Polytechnic Institute, Troy, N.Y.
Status of Projects

The paper on Stokes flow containing the general theory, the solution for the lens-shaped body including the drag for the hemispherical cup as well as a table of the drags for other configurations, has been completed by W. H. Pell.

Publications:
(2) The Stokes flow problem for a class of axially symmetric bodies. L. E. Payne and W. H. Pell. In manuscript.
(5) Note on the integration of the elastic plate equation with variable flexural rigidity. W. H. Pell. In manuscript.

FOURIER TRANSFORMS OF PROBABILITY DISTRIBUTION FUNCTIONS
Task 1104-12-5160/56-154

Origin: NBS
Sponsor: Office of Naval Research
Manager: F. Oberhettinger
Full task description: July-Sept 1955 issue, p. 20

Status: INACTIVE.

COMPUTATION OF OUTFLOW FROM A BREACHED DAM
Task 1104-12-5160/58-369

Origin and Sponsor: Army Map Service
Manager: V. M. Yevdjevich
Full task description: July-Sept 1958 issue, p. 16

Status: CONTINUED. The analysis of the outflow hydrograph from a breached dam has been continued, and the report on the influence of the negative wave and the effect of flow resistance on the free outflow hydrograph of rapid openings in bodies of water is about 80% finished.
It has been decided to change the title of this paper from that reported in the Oct-Dec 1958 issue to "The Effect of Sudden Water Release on the Reservoir Outflow Hydrograph". This, together with the earlier paper "The Analytical Integration of the Differential Equation for Water Storage" will form a portion of an interim report to the sponsor which will cover the year's activity on the project. This interim report has been started.

Publication:

RESEARCH ON SATELLITE ORBITS
Task 1104-12-5160/59-420

Origin: NBS
Sponsor: Office of Scientific Research, ARDC, USAF.
Manager: J. P. Vinti
Full task description: Oct-Dec 1958 issue, p. 15

Status: CONTINUED. Since the previous report it has appeared advisable to make a detour into the theory of the effect of oblateness on satellite motion, without drag.

By solving the Laplace equation in a system of orthogonal curvilinear coordinates, J. P. Vinti has found an axially symmetric solution for the potential that everywhere represents exactly the 1/r term and the second harmonic and takes into account about half of the fourth harmonic, with correct sign. This potential makes the Hamilton-Jacobi equation separable, so that it permits exact solution of the latter. This method, when worked out, should thus make any perturbation very small.

The kinetic equations of motion have been set up formally in terms of certain integrals which are now being investigated.
5. MATHEMATICAL AND COMPUTATIONAL SERVICES

1102-40-5126/54-13 AWARD OF PROCUREMENT CONTRACTS BY LINEAR PROGRAMMING

Origin and Sponsor: New York Quartermaster Procurement Agency
Manager: M. Paulsen
Full task description: Oct-Dec 1953 issue, p. 43
Status: Terminated. The sponsor has assumed the recoding and the continued running of the problem on his IBM 650.

3711-60-0009/54-30 SPECTRUM ANALYSIS

Origin: NBS, Division 4
Managers: C. D. Coleman, W. Bozman (4.1)
Full task description: Jan-Mar 1954 issue, p. 46
Status: Continued. The number of known atomic energy levels of thorium I has been increased from 5 even and 23 odd levels to 20 even and 170 odd levels. The hafnium I analysis is nearly completed. After a search for new even levels has been made, the list will be prepared for publication.

Work continued on the revision of Kayser's "Table of Wave Numbers." Four hundred pages of Volume II have been calculated and printed in a form suitable for publication.

A paper covering work done on this project was presented to the Optical Society Meeting in New York on April 4.

3711-60-0009/54-38 EQUATION OF STATE OF REAL GASES
(formerly COMPRESSIBILITY FACTORS OF DRY AIR)

Origin: NBS, Section 3.2
Manager: M. Paulsen
Full task description: Jan-Mar 1954 issue, p. 48
Status: Continued. A routine was written and checked out using an Nth order Floating Point Interpolation Subroutine (Share-Distribution No.265). This routine enables one to subtabulate an existing table (reads in regular DEC cards as the existing table), rearrange and/or omit any number of columns of the existing table (and at same time subtabulate if desired). The resulting table can be printed on-line and/or punched on cards with the heading and format chosen by the user. Writing the resulting table on tape is possible, but the code has not been checked out.

Another routine is being written, using Fortran, which will evaluate

\[ f_i(T) = AT^{-2} + BT^{-1} + C + DT^1 + ET^2 + FT^3 + GT^{-1}L0G_10 T + HTL0G_10 T + IT^2L0G_10 T \]

and print a table with the T argument and the corresponding values of \( f_i(T) \), where \( i \) can vary from 1 to 5.
3711-60-0009/55-68 CRYSTAL STRUCTURE CALCULATIONS
Origin: NBS, Division 9
Managers: P. O'Hara, S. Block (9.7)
Full task description: Jan-Mar 1955 issue, p. 10
Status: Continued. A final structure was determined for the monoclinic form of the Na₄P₂O₉·4H₂O crystal. Structure factors computed using the present atomic coordinates agree very well with observed structure factors and the structure is chemically reasonable.

The new version of the Fourier synthesis routine has been completed, and several three-dimensional maps have been computed.

A new and more powerful least square refinement program has been used successfully in the past quarter. This program was written by Dr. William Busing of the Oak Ridge National Laboratory, and although it requires more time per refinement cycle the total number of cycles is considerably reduced.

3711-60-0009/55-82 THERMOMETER CALIBRATIONS
Origin: NBS, Section 3.1
Manager: S. Prusch
Full task description: Jan-Mar 1955 issue, p. 20
Status: Continued. ITS constants and tables were computed for approximately 23 thermometers under test. The code for computing low temperature constants and tables is being tested.

1102-40-5126/55-121 ELECTRON PENETRATION
Origin and Sponsor: NBS, Section 4.8
Manager: S. Peavy
Full task description: Apr-June 1955 issue, p. 19
Status: Continued. The sponsor is using the code to make runs as necessary.

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: Completed. Solutions have been obtained for a 100x100 system of equations.

1102-40-5126/56-166 SCF-LCAO SOLUTION OF SOME HYDRIDES
Origin and Sponsor: NBS, Section 5.9
Managers: E. Haynsworth, P. Walsh
Full task description: Jan-Mar 1956 issue, p. 27
Status: Continued. The codes are now being used by the sponsor for production runs.
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. Calculations were performed on seven laboratory sets of gage blocks.

1102-40-5126/57-219 THERMAL PROPERTIES
Origin and Sponsor: NBS, Section 3.2
Manager: R. Varner
**Full task description:** Oct-Dec 1956 issue, p. 30
**Status:** Reactivated. Additional production runs have been made at the request of the sponsor.

1102-40-5126/57-221 BESSEL FUNCTIONS FOR COMPLEX ARGUMENTS
Origin and Sponsor: Diamond Ordnance Fuze Laboratories, Department of the Army
Manager: R. Zucker
**Full task description:** Oct-Dec 1956 issue, p. 31
**Status:** Continued. Sixteen cases were run to evaluate the Bessel and Hankel functions for complex arguments up to order n specified.

1102-40-5126/57-222 ROOTS OF POLYNOMIALS
Origin and Sponsor: Naval Research Laboratory
Manager: J. P. Menard
**Full task description:** Oct-Dec 1956 issue, p. 32
**Status:** Completed. Results have been transmitted to the sponsor.

3711-60-0009/57-223 SELF-CONSISTENT FIELDS
Origin: NBS, Section 3.2
Manager: E. V. Haynsworth
**Full task description:** Apr-June 1957 issue, p. 28
**Status:** Continued. Some minor modifications were made in the A-matrix and SCF programs. Several production runs have been made.

3711-60-0009/57-229 APPLICATION OF ELECTRONIC DATA PROCESSING MACHINERY TO PAYROLL OPERATIONS
Origin: NBS, Section 40.0
Managers: M. Paulsen, P. Ruttenberg
**Full task description:** Jan-Mar 1957 issue, p. 36
**Status:** Inactive.
Status of Projects

1102-40-5126/57-236 SELF CONSISTENT FIELDS--EIGENVALUES
Origin and Sponsor: NBS, Section 3.6
Manager: E. Haynsworth
Full task description: Apr-June 1957 issue, p. 30
Status: Continued. A few cases have been prepared and run. In one case
the process did not converge to a solution, and further investigation
may be necessary to determine why oscillation occurred.

3711-60-0009/57-247 MECHANICAL IMPEDANCE
Origin: NBS, Section 6.1
Managers: J. P. Menard, M. D. Burkhard (6.1)
Full task description: Apr-June 1957 issue, p. 32
Status: Terminated. Several production runs have been made directly by
the sponsor. The program will continue in production under the sponsor's
direction. (In future reports production time will be reported in the
section, "Application of Automatic Computer.")

3711-60-0009/57-248 THE EVALUATION OF A TRIPLE INTEGRAL FOR THE
SOLUTION OF NEGATIVE ION DETACHMENT
Origin: NBS, Section 4.6
Manager: S. Peavy
Full task description: Apr-June 1957 issue, p. 34
Status: Inactive.

3711-60-0009/57-250 AUTOMATIC REDUCTION OF SPECTROPHOTOMETRIC DATA
Origin: NBS, Section 2.1
Manager: W. C. Rheinboldt
Full task description: July-Sept 1957 issue, p. 31
Status: Terminated. Several production runs have been made directly by the
sponsor. The program will continue in production under the sponsor's
direction. In future reports production time will be reported in the
section, "Application of Automatic Computer."

1102-40-5126/57-251 CURRENT NOISE AND FIXED RESISTORS
Origin and Sponsor: NBS, Section 1.6
Manager: D. Sumida
Full task description: July-Sept 1957 issue, p. 32
Status: Completed.

3711-60-0009/58-254 REPRODUCTION OF COLOR- AND SPECTRAL-ENERGY
DISTRIBUTION OF DAYLIGHT AND OTHER ILLUMINANTS
Origin: NBS, Section 2.3
Manager: W. C. Rheinboldt
Full task description: July-Sept 1957 issue, p. 32
Status: Terminated. Several production runs have been made directly by the
sponsor. The program will continue under the sponsor's direction.
In future reports production time will be reported in the section,
"Application of Automatic Computer."
Status of Projects

1102-40-5126/58-263  GAS TUBE CHARACTERISTIC
Origin and Sponsor: Diamond Ordnance Fuze Laboratories, Department of the Army
Manager: I. A. Stegun
Full task description: July-Sept 1957 issue, p. 35
Status: Continued. Four runs were made, and the results were transmitted to the sponsor.

1102-40-5126/58-264  THEORY OF IONIZATION PROBABILITY
Origin and Sponsor: NBS, Section 4.6
Manager: S. Peavy
Full task description: Oct-Dec 1957 issue, p. 30
Status: Completed. Requested production runs were made. Results were transmitted to the sponsor.

3711-60-0009/58-266  DEPOLYMERIZATION, II
Origin: NBS, Section 7.6
Manager: L. S. Joel
Full task description: July-Sept 1957 issue, p. 36
Status: Continued. A new code for terminal initiation has been written using Fortran. It is being checked on a system of 1,000 equations.

3711-60-0009/58-267  CONVERSION OF THE CIE-CHROMATICITY COORDINATES INTO THE MUNSELL COLOR SYSTEM
Sponsor: NBS, Section 2.1
Manager: W. C. Rheinboldt
Full task description: July-Sept 1957 issue, p. 37
Status: Terminated. Several production runs have been made directly by the sponsor. The program will continue in production under the sponsor's direction. (Production time will be reported hereafter in the section, "Application of Automatic Computer.")

1102-40-5126/58-269  MOLECULAR STRUCTURE, IV
Origin and Sponsor: Naval Research Laboratory, USN
Manager: P. J. O'Hara
Full task description: July-Sept 1957 issue, p. 38
Status: Continued. In the past quarter a final structure was determined for the spurite crystal. Least square refinement of position and temperature parameters was made by means of the NYXR1 program.

The structure determination of this crystal was complicated by a new effect in that there exists a rational dependence of atoms. This necessitates a minor modification in the phase determination procedures and creates a need for a program to detect rational dependence.

Phase determination calculations were started for the arginine crystal, which also exhibits rational dependence of atoms. A means of correcting for this effect is under consideration.
Status of Projects

1102-40-5126/58-270  MATHEMATICAL PROBLEMS RELATED TO POSTAL OPERATIONS
Origin:  NBS
Sponsor:  Post Office Department, Office of Research and Engineering
Managers:  B. K. Bender, A. J. Goldman
Full task description:  Oct-Dec 1958 issue, p. 22
Status:  Continued. The report on the "Analytic Comparison of Suggested Configurations for Automatic Mail Sorting Equipment" has been completed. A report is being prepared on the extent to which incoming mail should be mechanically sorted for postal carriers.

1102-40-5126/58-272  THERMODYNAMIC PROPERTIES OF REAL GASES
Origin and Sponsor:  NBS, Section 3.2
Manager:  J. P. Menard
Full task description:  Oct-Dec 1957 issue, p. 32
Status:  Continued. An editing code is being written for printing out previously computed data already stored on magnetic tape in a suitable form for publication.

1102-40-5126/58-274  CALCULATIONS FOR d-SPACINGS, II
Origin and Sponsor:  NBS, Division 9
Manager:  R. Zucker
Full task description:  July-Sept 1957 issue, p. 38
Status:  Continued. About 100 calculations for d-spacings for orthogonal, hexagonal and orthorhombic crystals were carried out this quarter, and redetermination of unit cell constants by least squares fitting to a measured d-spacing was performed for about 20 crystals.

3711-60-0009/58-294  NUCLEAR SCATTERING OF PHOTONS
Origin:  NBS, Section 4.8
Manager:  J. P. Menard
Full task description:  Oct-Dec 1957 issue, p. 36
Status:  Continued. A misprint has been found in the equation for the dispersion integral as defined in the Oct-Dec 1958 status report (p.23). The equation should read

\[ I(E) = P \int_0^\infty \frac{G(E')}{E' - E^2} dE', \]

where P denotes that the principal value of the integral is to be taken. Production runs continued under the sponsor's direction.
Status of Projects

1102-40-5126/58-298 ANALYSIS OF SPECTROCHEMICAL DATA
Origin and Sponsor: NBS, Section 5.10
Managers: S. Peavy, R. N. Varner
Full task description: Oct-Dec 1957 issue, p. 39
Status: Continued. The Fortran code for the third phase of the problem has been checked out. Several runs using the code for the second phase of the problem have been made by the sponsor.

1102-40-5126/58-299 TIME-DEPENDENT SCHRODINGER EQUATION
Origin and Sponsor: NBS, Section 3.1
Manager: A. Schopf
Full task description: Oct-Dec 1957 issue, p. 39
Status: Continued. Five more production runs have been made for various domains, time steps, and parameters $\sigma$. The results agree well with previous results and have been transmitted to the sponsor.

1102-40-5126/58-300 LAMINAR MIXING IN BOUNDARY LAYERS
Origin: Polytechnic Institute of Brooklyn
Sponsor: Air Force Office of Scientific Research
Manager: W. C. Rheinboldt
Full task description: Oct-Dec 1957 issue, p. 40
Status: Completed.

1102-40-5126/58-304 TRANSPORT PROPERTIES OF AIR AT ELEVATED TEMPERATURES
Origin and Sponsor: NBS, Section 3.2
Managers: P. J. Walsh, J. D. Waggoner
Full task description: Oct-Dec 1957 issue, p. 40
Status: Continued. Revisions have been made in the code for calculating the transport properties. The input data is now available from tape, and the results of the calculations are also processed onto tape. Codes have been written to rearrange and print the final results in table form.

The codes for computing the transport properties $K$, $\eta$ and $C$ will be joined together by a supervisory routine which will determine the calculations of these transport properties for all pressures at a specified temperature. The amount of read-in time and data handling will thus be considerably reduced.

1102-40-5126/58-306 INTERPOLATION OF COLOR MIXTURE FUNCTIONS
Origin and Sponsor: NBS, Section 2.1
Manager: W. C. Rheinboldt
Full task description: Oct-Dec 1957 issue, p. 42
Status: Terminated. A number of production runs have been made directly by the sponsor. The program will continue in production under his direction. (Production time will be reported hereafter in the section, "Application of Automatic Computer.")
Status of Projects

1102-40-5126/58-307 STUDY OF SURFACE TENSION
Origin and Sponsor: NBS, Section 9.2
Manager: R. Arms
Full task description: Oct-Dec 1957 issue, p. 43
Status: Inactive.

1102-40-5126/58-308 OSCILLATING SPHERE
Origin and Sponsor: NBS, Section 3.4
Manager: S. Prusch
Full task description: Oct-Dec 1957 issue, p. 43
Status: Inactive.

1102-40-5126/58-312 RESPONSE FUNCTION, II
Origin and Sponsor: NBS, Section 4.11
Manager: A. Beam
Full task description: Jan-Mar 1958 issue, p. 33
Status: Continued. The sponsor has made several runs on the 704.

1102-40-5126/58-316 INTERSECTION CAPACITY STUDY
Origin and Sponsor: Bureau of Public Roads
Managers: S. Peavy, J. M. Cameron
Full task description: Jan-Mar 1958 issue, p. 33
Status: Continued. A code has been written for the analysis of the intersection capacity study. Checking of the code is under way.

1102-40-5126/58-322 PROPAGATION CONSTANT OF A SOUND WAVE
Origin and Sponsor: NBS, Section 6.1
Manager: R. J. Arms
Full task description: Jan-Mar 1958 issue, p. 34
Status: Completed.

1102-40-5126/58-333 CALCIUM HYDROXIDE
Origin and Sponsor: NBS, Section 9.0
Manager: P. O'Hara
Full task description: Jan-Mar 1958 issue, p. 36
Status: Inactive.

1102-40-5126/58-337 GEORGETOWN LANGUAGE TRANSLATION EXPERIMENTS
Origin and Sponsor: Georgetown University
Manager: R. J. Arms
Full task description: Jan-Mar 1958 issue, p. 37
Status: Inactive.
Status of Projects

1102-40-5126/58-339 COMPUTATION OF VISCOELASTICITY PROPERTIES OF MATERIALS

Origin and Sponsor: NBS, Section 3.4
Manager: H. Oser
Full task description: Jan-Mar 1958 issue, p. 38
Status: Continued. Production runs have been made and the results were turned over to the sponsor. A report on these computations is in preparation and will be submitted to the Office of Naval Research, Washington, D.C.

1102-40-5126/58-343 MINIMIZATION PROBLEM

Origin and Sponsor: Naval Research Laboratory
Manager: S. Peavy
Full task description: Jan-Mar 1958 issue, p. 40

1102-40-5126/59-348 RUSSIAN-TO-ENGLISH MACHINE TRANSLATION

Origin: NBS
Sponsor: Office of Ordnance Research, U. S. Army
Manager: I. Rhodes
Full task description: Oct-Dec 1958 issue, p. 26
Status: Continued. As reported previously, programming and coding for the glossary lookup of individual source words in a sentence has been completed and is in use. Coding has been started for the organization of the separate words into a meaningful sentence that correctly renders the intention of the original.

1102-40-5126/58-359 VELOCITY DISTRIBUTION IN BOUNDARY LAYERS

Origin and Sponsor: NBS, Section 11.4
Manager: W. C. Rheinboldt
Full task description: Apr-June 1958 issue, p. 32
Status: Inactive.

3711-60-0009/58-360 DIFFUSION COEFFICIENTS

Origin: NBS, Section 5.2
Manager: W. C. Rheinboldt
Full task description: Apr-June 1958 issue, p.32
Status: Continued. Several production runs have been made directly by the sponsor. The program will continue in production under the direct supervision of the sponsor.
1102-40-5126/58-361  CALCULATIONS FOR SPECTRUM OF DIPOLE RADIATION  

**Origin and Sponsor:** Naval Research Laboratory  
**Manager:** R. J. Arms  
**Full task description:** Apr–June 1958 issue, p. 33  
**Status:** Continued. By agreement with the sponsor, the random vector integration has been discontinued. In its place, a new and comparatively simple program has been started. Several production runs on the dipole radiation code have been turned over to the sponsor.

1102-40-5126/58-366  RADIATION PATTERNS OF ANTENNAS  

**Origin and Sponsor:** U. S. Information Agency, Department of State  
**Managers:** R. T. Moore, P. J. Walsh  
**Full task description:** Apr–June 1958 issue, p. 35  
**Status:** Continued. Part (1) (see full write-up): The codes for all four tables have been written and checked out. Tables (a), (b) and (c) have already been produced, and copies have been transmitted to sponsor. Part (2). The code has been checked out and results for approximately 80 antennae have been submitted to sponsor. In some cases both primary and secondary lobe information was obtained.

1102-40-5126/58-368  INTENSITY FUNCTIONS AND CROSS SECTIONS OF LIGHT SCATTERED BY SPHERICAL PARTICLES  

**Origin and Sponsor:** U. S. Army Signal Research and Development Laboratories, Atmospheric Physics Branch, Belmar, N. J.  
**Manager:** H. Oser  
**Full task description:** July–Sept 1958 issue, p. 32  
**Status:** Continued. Production continued with the computation of tables of moduli and intensities. Results have been submitted to the sponsor.

1102-40-5126/59-374  END-EFFECT IN THE CYLINDRICAL ROTATIONAL VISCOMETER  

**Origin and Sponsor:** NBS, Section 7.1  
**Managers:** A. Schopf, J. P. Menard  
**Full task description:** July–Sept 1958 issue, p. 34  
**Status:** Inactive.

1102-40-5126/59-381  BOOLEAN FUNCTIONS AND PICTORIAL DATA PROCESSING  

**Origin and Sponsor:** NBS, Section 12.5  
**Manager:** B. Bender  
**Full task description:** July–Sept 1958 issue, p. 35  
**Status:** Completed. Two further programs were written for SEAC to aid in obtaining one simplest normal equivalent of any truth function of up to 14 variables. A paper describing the process is being prepared.
1102-40-5126/59-388 HEAT PUMP CALCULATIONS

Origin and Sponsor: NBS, Section 10.3
Manager: R. Zucker

Objective: To perform general computations on the IBM 704 that become necessary in connection with the investigation of the heat pump used for heating and cooling of homes and in a research program directed towards design data on heat pumps.

Background: During the early testing of samples, calculations using desk computers became too laborious. By the use of psychrometric tables and the adapting of known equations, it is possible to carry out the computations on the IBM 704 with a considerable saving of time.

The problem was proposed by J. C. Davis(10.3).

Status: New. The code has been prepared and checked, and runs were made for many sets of data. The results of early test runs were checked against corresponding results obtained by desk calculation methods and close agreement was found.

1102-40-5126/59-389 FREQUENCY ALLOCATION

Origin and Sponsor: Civil Aeronautics Administration
Manager: L. S. Joel

Full task description: Oct-Dec 1958 issue, p. 29

Status: Continued. A code for chains of substitutions of length of arc, and a set of data file updating and editing codes, have been written and checked. Investigations continue for the existence of a complete solution in closed form.

3711-60-0009/59-393 HEAT TRANSFER IN THE PRESENCE OF MOISTURE

Origin: NBS, Section 10.6
Manager: F. L. Alt

Full task description: July-Sept 1958 issue, p. 38

Status: Completed.

1102-40-5126/59-394 VARIATIONAL CALCULATION OF SLOW ELECTRON SCATTERING BY HYDROGEN ATOMS

Origin and Sponsor: NBS, Section 4.6
Manager: A. Beam

Full task description: Oct-Dec 1958 issue, p. 30

Status: Continued. The p-wave computation was found to be unsatisfactory at very low energies due to defects in the boundary condition of the trial function. A new condition has been introduced and the changes are being made in the Fortran code for the p-wave.
1102-40-5126/59-403 COMPUTATION OF COLOR FADING
Origin and Sponsor: NBS, Section 2.1
Managers: W. C. Rheinboldt, J. P. Menard
Full task description: Oct-Dec 1958 issue, p. 30
Status: Continued. The revised code for the conversion of CIE-chromaticity coordinates into terms of the Munsell renotation system has been written and completely checked out. The program performs this conversion at the speed of approximately 3.5 seconds per sample as compared to 24 seconds per sample for the previous code.

A code has been written and completely checked out for computing color differences with Godlove's formula,

$$\Delta I = 5 \left\{ 2c_1 c_2 \left[ 1 - \cos \left( 2\pi \frac{H_1 - H_2}{100} \right) \right] + (c_1 - c_2)^2 + 16(v_1 - v_2)^2 \right\}$$

[in N.B.S. units] where $H_1, v_1, c_1$ and $H_2, v_2, c_2$ are the Munsell renotations of the given samples.

Both codes have been written such that their inputs and outputs are compatible.

NBS Section 2.1 has used the first code for evaluating the Munsell renotations for approximately 1700 samples and the second code for obtaining color differences on approximately 600 pairs of samples. These samples were obtained as part of a test-program for a commercial company. The test-program will be continued under the direct supervision of NBS Section 2.1.

1102-40-5126/59-412 DYNAMICS OF PNEUMATIC PRESSURE REDUCERS
Origin and Sponsor: NBS, Section 3.2
Manager: W. Gautschi
Full task description: Oct-Dec 1958 issue, p. 31
Status: Continued. A particular system has been solved and the results transmitted to the sponsor. A supplementary code has been written to determine approximations to the stability characteristics of the problem. Production runs are under way.

1102-40-5126/59-407 FOURIER COEFFICIENTS
Origin and Sponsor: Diamond Ordnance Fuze Laboratories, Department of the Army
Manager: R. Zucker
Objective: To calculate (a) Fourier coefficients $A_n$ and $B_n$ for $n$ equally spaced abscissas, (b) the amplitude of the frequency component, and the frequency, and (c) the integral of the series.
Background: The data is the result of measurements of an electromagnetic field using a loop antenna, the output of which is the derivative of the field. In the telemetering circuitry in some cases electrical integrators were used, and in other cases the output of the antenna was recorded directly. It is desired to obtain the actual frequency versus amplitude spectrum of the electromagnetic field.

The problem was proposed by R. R. Puttcamp (DOFL).
Status of Projects

Status: New. The code has been prepared and checked, and production runs were started.

1102-40-5126/59-414 INFINITE SYSTEMS

Origin and Sponsor: NBS, Division 3

Manager: R. Zucker

Objective: To solve the set of simultaneous equations:

\[ \Sigma_{n} H_{f,n}^{m-n} \gamma^{n-m} e^{-\frac{\gamma}{4}(n-m)} B_{n} = -H_{f,m}^{*} \gamma^{\sqrt{\epsilon}} \]

where \( H_{f,m}^{*} \gamma^{\sqrt{\epsilon}} \) is the complex conjugate of \( H_{f,m} \gamma^{\sqrt{\epsilon}} \)

for the unknowns \( B_{n} \), and

\[ H_{f,n}^{m}(\alpha) = \frac{1}{\sqrt{f! \cdot n!}} \Sigma_{r=0}^{\min[f,n]} \binom{f}{r} \binom{n}{r} r! \left( \frac{\alpha i}{\sqrt{2}} \right)^{f+n-2r} \]

Sets of values of \( B_{n} \) are desired as a function of \( \epsilon \) where \( \epsilon \) is given and lies in the region \( 0 < \epsilon < 10 \), for \( \gamma = \frac{1}{4}, 1, 4 \), and \( m = 0,1,2,3,4,5 \), for select cases. Also, to evaluate for each solution the normalization condition:

\[ \left[ \Sigma_{n=0}^{[\epsilon+n-1]} \left[ \frac{\epsilon-n+m}{\epsilon} \right]^{\frac{1}{2}} \right] \left| B_{n} \right|^{2} = 1. \]

Background: These equations arise in the quantum-mechanical calculation of the probabilities of transfer of translational to vibrational energy in collisions between atoms and diatomic molecules. The particular form of the equations is peculiar to a hard sphere interaction potential between the atom and the diatomic molecule for the case in which the atom approaches the molecule along the axis of the molecule. The equations appear in the literature: Castellan and Hulburt, J. Chem. Phys. 18, 312(1950).

The problem was requested by R. Rubin and K. E. Shuler (Div. 3).

Status: New. The code was checked, and calculations were carried out for the following sets of parameters: \( \gamma = 1, m = 0,1,2 \), for various values of \( \epsilon \) in the range \( 0 < \epsilon \leq 5 \).
Status of Projects

1102-40-5126/59-415  COMPLEX LEGENDRE FUNCTIONS
Origin and Sponsor: Diamond Ordnance Fuze Laboratories, Department of the Army
Manager: R. Zucker
Objective: To evaluate a double summation of the form

$$\sum_{n=0}^{\infty} \sum_{m=-n}^{n} F(z)$$

where F(z) involves expressions of the following types:

$$A_{mnp} = \int_{0}^{1} A \cdot B \, dt \quad \text{and} \quad E_{mp} = C \cdot D.$$  

Here A, B, C, and D may be $P^m_n$ or $P^{-m}_{-n}$ (associated Legendre functions) for complex z or its conjugate.

Background: The computations arise in studies of the absorption spectra of ferides. The problem was proposed by O. R. Cruzan (DOFL).

Status: New. The code for evaluating the Legendre function and its derivative and the associated integrals was completed and checked out. Certain expected maxima of $E_{mp}$ have been obtained.

1102-40-5126/59-418  P-WAVE EQUATION
Origin and Sponsor: NBS, Section 4.8
Managers: S. Peavy, R. Varner
Objective: To find the solution of the following second order differential equations and evaluate the integrals:

1. Unperturbed Equation

$$\left(\frac{d^2}{dr^2} - \frac{2}{r^2} + K^2\right) u_p(r) = 0; \quad \int_{r}^{\infty} e^{-r_1} \frac{u_p(r_1)}{r} \, dr_1$$

2. Non-exchange Equation

$$\left(\frac{d^2}{dr^2} - \frac{2}{r^2} + 2e^{-2r} \left(1 + \frac{1}{r} + K^2\right)\right) u_p(r) = 0;$$

$$\int_{r}^{\infty} e^{-r_1} \frac{u_p(r_1)}{r_1} \, dr_1$$
3. Exchange Equation

\[
\left[ -\frac{d^2}{dr^2} + \frac{2}{r} - K^2 - 2e^{-2r} \left\{ 1 + \frac{1}{r} \right\} \right] u_p(r)
\]

\[
\pm \left[ \frac{8e^{-r}}{3} \left\{ \frac{1}{r} \int_0^r r_1 e^{-r_1} u_p(r_1) \, dr_1 + \int_0^\infty \frac{e^{-r_1} u_p(r_1)}{r_1} \, dr_1 \right\} - \frac{2}{r} \int_0^r e^{-r_1} \frac{u_p(r_1)}{r_1} \, dr_1 \right] = 0
\]

The boundary conditions are:

\[ u_p(0) = 0 \]
\[ u'_p(0) = 0 \]
\[ u''_p(0) = 2K^2/3 \]
\[ u_p(r + \Delta r) = 2u_p(r) - u_p(r - \Delta r) + (\Delta r)^2 u''_p(r) \]
\[ u_p(\Delta r) = (\Delta r)^2 \frac{K^2}{3} \]
\[ u'_p(r) = \frac{1}{\Delta r} \left[ u_p(r + \Delta r) - u_p(r) - \frac{u''_p(r)(\Delta r)^2}{2} \right] \]

While solving the second order differential equation \( \delta \) will approach a limit where

\[ \delta = \xi_e + \varphi_e \]
\[ \xi_e = f(K,r) \]
\[ \varphi_e = f(K,r,u_p(r), u'_p(r)) \]

**Background:** The problem is concerned with the scattering of electrons from hydrogen atoms and the computation of a phase shift which is related to the solution of a differential equation. Various differential equations are given corresponding to degrees of approximation in the description of the above process.

**Status:** New. Fortran programs have been written for the three equations. Results for the non-exchange and unperturbed equations have been submitted to the sponsor.
Status of Projects

1102-40-5126/59-427 MAGNETIC SCATTERING OF NEUTRONS BY PARAMAGNETIC MnF₂

Origin and Sponsor: Naval Research Laboratory
Manager: W. Hall

Objective: To evaluate the differential cross section and the second moment of neutron energy transfer for neutrons in the 1A range incident on MnF₂ at temperatures T such that T >> θ, θ being the Curie-Weiss constant. Theoretical studies of the energy spectrum of neutrons scattered magnetically by exchange coupled lattices in the paramagnetic domain are to be employed to interpret the corresponding experimental results in terms of the coupling constants of these compounds.

Background: The following exchange-coupling model for MnF₂ was chosen for these computations: the 8 Mn²⁺ ions at the nearest-neighbor sites are coupled antiferromagnetically with the central Mn⁺² ion which is also coupled with the 2 nearest neighbors along the c-axis. The latter coupling can be either ferromagnetic or antiferromagnetic. The results will serve to illustrate a general theory of the magnetic scattering of slow neutrons by paramagnetic substances and to evaluate the results of current experiments on MnF₂ at the NRL reactor.

The problem was submitted by A. W. Saenz.

Status: New.
6. STATISTICAL ENGINEERING SERVICES

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

Origin: NBS
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) Transistor Measurement Experiment: A design of a large scale transistor experiment involving automatic data recording was worked out. Specifications for data processing on high speed computers were suggested. Work on this project is being done for G. Conrad, Section 1.6.

(2) Color Matching: Methods were developed for the analysis, using multivariate techniques, of individual observer data from a large scale color matching investigation. This work was carried on in collaboration with I. Nimeroff, Section 2.01.

(3) Machine (704) Analyses of data and/or the preparation of special codes were under way for:
   H. B. Kirkpatrick, 9.4
   M. J. Kerper, 9.2
   J. Mandel, 7.5
   F. M. Reinhart, 8.4
   H. C. Allen, 4.2
   J. B. Wachtman, 9.1

(4) An in-hours course, "Design of Multi-factor Experiments" is being presented by W. S. Connor and M. Zelen.

(5) Use of Sampling Methods in Studies of Post Office Operation: N. Severo continued his collaboration with B. M. Levin and A. Newman of Section 12.5 on the use of sampling methods for estimation of parameters of distributions arising in their study of Post Office operations. Dr. Severo presented a paper "A statistician and the Post Office: a case history in operations research" before the American Society for Quality Control on March 5, giving a summary of the use of the chain-ratio method in studies of mail distribution.
Status of Projects

Publication:

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. W. J. Youden participated in a meeting of the NRC-NSF Ship Structure Committee on planning the balance of the program for exploring uniformity of steel plates from current production. Statistical studies on the relation between nil-ductility transition temperature and several physical and chemical properties of two types of ship steel were completed.

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 IV (Miscellaneous Topics) was circulated for comment. Three major sections of Part II (Qualitative Data) were included in another report for limited distribution for comment. A draft of a section on Multiple Regression and a draft of a section on Sensitivity Testing were completed. Work proceeded on preparing examples for all sections.

Publications:
(2) The relation between confidence intervals and tests of significance—a teaching aid. Mary G. Natrell. Submitted to a technical journal.
STATISTICAL SERVICES
Task 1103-40-5150/58-346

Origin and Sponsors: Various Agencies
Manager: J. M. Cameron
Full task description: Jan-Mar 1958 issue, p. 45

Status: CONTINUED. Work was done during the quarter for the following agencies:

1. Veterans Administration Hospital, Perry Point, Maryland: The analysis of a set of data on mental patients was completed, and the results were transmitted to the sponsor.
2. Bureau of Public Roads: See task 1102-40-5126/58-316, p. 23, for report on this task done jointly with the Computation Laboratory.
3. Chemical Corps: Analysis of a problem arising in the work of the Chemical Corps was continued in collaboration with A. J. Goldman of the Numerical Analysis Section (11.1).
The record of the use of the IBM 704 for the period January 1 through March 31 is as follows:

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Total time for the quarter (MINUTES).. 4,598 6,866 40,084

Total time for the quarter (HOURS) ... 76.6 114.4 668.1

*Problem programmed in the Computation Laboratory; production runs continued under direction of sponsor.

**Problem programmed by sponsor and run under his direction.

***Machine time provided under contract.

°Classified task.
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 Statistics Seminar

SEVERO, N. C. Mathematical problems associated with measurements made by matching known standards. March 17.

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

CANNON, E. W. The evolution of programming methods. Presented before the Central Ohio Association for Computing Machinery, Columbus, Ohio, March 21.


OSTROWSKI, A. M. Quadratic equation--A study of the regula falsi and difference equations. Presented at a Joint Mathematics Colloquium


WEGSTEIN, W. UNCOL--Useful avenue or blind alley. Presented before the Delaware Valley Chapter of the Association for Computing Machinery, Philadelphia, Penn., March 19.

Publication Activities

1. PUBLICATIONS THAT APPEARED DURING THE QUARTER

1.3 Technical Papers


(4) The exponential integral\( \int_{1}^{\infty} e^{-xt} \frac{-n}{t} dt \) for large values of n. W. Gautschi. J. Research, NBS, 62, 123-125(1959), RP2941.


(20) From formulas to computer oriented language. J. Wegstein. Communications ACM 2, 6-8 (1959).


2. MANUSCRIPTS IN THE PROCESS OF PUBLICATION MARCH 31, 1959

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) Fractional factorial experiment designs for factors at three levels. To appear as NBS Applied Mathematics Series 54.

2.3 Technical Papers


(2) A theoretical foundation for the numerical evaluation of worth in subjective allocation problems. R. J. Aumann. Submitted to a technical journal.

(3) Time phasing in the allocation problem. R. J. Aumann. Submitted to a technical journal.


(8) Construction of fractional factorial designs of the mixed $2^m3^n$ series. W. S. Connor. Submitted for publication.


(15) Generating functions for formal power series in noncommuting variables. K. Goldberg. Submitted to a technical journal.


(23) Field convexity of a linear transformation. A. J. Goldman and M. Marcus. Submitted to a technical journal.


(30) On the derivative of Bessel functions with respect to the order. F. Oberhettinger. Submitted to a technical journal.

(31) Linear differential equations of the second order with a large parameter. F. W. J. Olver. Submitted to a technical journal.


(39) On the power of some rank order two-sample test. J. Rosenblatt. Submitted for publication.

(40) The non-central $\chi^2$ as a test statistic. N. C. Severo. Submitted to a technical journal.


(47) Rotational properties of two-dimensional lattices. J. P. Vinti. Submitted to a technical journal.


(55) Analysis of two-factor classifications with respect to life tests. M. Zelen. Submitted for publication.

(56) Factorial experiments in life testing. M. Zelen. Submitted to a technical journal.


2.4 Reviews and Notes


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 laboratories in Boulder, Colo., 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 publications, appears on the inside front cover.

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