

INTRODUCING

THE IBM 650

PROGRAM LIBRARY

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The IBM 650 Program Library was formed in the belief that present and future users of the IBM 650 can profit by exchanging programs through the medium of a central library. To this end IBM is acting as publisher and distributor of contributed programs of general interest. A manual entitled "Library Program Abstracts for the IBM 650" is published as a reference to these programs maintained at the headquarters of the IBM Data Processing Division.

At present, the IBM 650 Program Library includes over 200 programs. The abstracts of these programs are designed to provide sufficient information to enable the potential user to determine whether or not a particular program will meet his needs. Thus the amount of reading required of a potential user is minimized. The manual is published in loose leaf form to simplify updating and revision. All library programs have been classified by application and the arrangement of the abstracts in the manual is in accordance with this classification.

In this booklet we would like to give you a representative sample of the programs which are in the IBM 650 Program Library. Accompanying each title is a brief description of the purpose of the program.

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1.0.000 UTILITY PROGRAMS

OPTIMIZING PROGRAM -- 1.1.002

Automatically assigns optimum locations to the instructions and data of a program.

SOAPY -- 1.1.005

SOAPY is a modification of the original SOAP so that it may be used on a numeric 650.

SEVEN-PER-CARD LOADER -- 1.2.002

Loads one to seven words per card into consecutive drum locations beginning at the location specified by a control word in each card.

FIVE-PER-CARD LOADING ROUTINE -- 1.2.003

Loads five words per card into random drum locations specified by control words in the card.

LOADING PROGRAM FOR MATRICES AND SIMULTANEOUS EQUATIONS -- 1.2.005

Loads fixed-point data for square matrices of order n , or for simultaneous equations with an n th order coefficient matrix and b constant vectors, converting the data from fixed to floating data.

SEVEN-PER-CARD PUNCH ROUTINE -- 1.3.001

Punches, seven words to a card, the contents of consecutive drum locations between two address limits specified on a control card.

PUNCH OUT FOR THE SOLUTION OF SIMULTANEOUS EQUATIONS -- 1.3.003

Converts solutions of b systems of simultaneous linear equations with a common $n \times n$ coefficient matrix and b right hand sides (constant vectors) from floating to fixed point form and punches each solution as a row vector.

INVERSE MATRIX PUNCH OUT -- 1.3.004

Punches out a floating point inverse matrix into load cards containing seven matrix elements per card.

AUTOPSY -- 1.3.006

Searches for those locations with any desired 4 digit number in either the data or instruction address position and punches the drum address and contents of each such location.

STORAGE DUMP -- 1.3.007

Punches a specified block of storage, 8 words per card.

AVAILABILITY -- 1.3.009

Produces a SOAP Availability Punchout from a deck of load cards that may be single-instruction, four-per-card, seven-per-card, or any mixture of these three types.

FLOW TRACER -- 1.4.002

A symbolic program to be assembled by SOAP which will trace designated locations only, called "bus stops."

SYMBOLIC BRANCH TRACING ROUTINE -- 1.4.004

A symbolic program to be assembled by SOAP which will trace all branch instructions (except READ) in a program in order that the flow of the program with respect to a block diagram or a test problem may be easily followed. The tracing routine may be modified to trace all instructions.

TAPE DUPLICATION -- 1.5.001

This program will duplicate either numerical or alphabetic tapes. Tapes may be labeled or unlabeled.

SEVEN PER CARD PUNCH FROM TAPE -- 1.5.002

Designed to load consecutively the drum on tape, and then punch seven instructions per card. This procedure provides the following advantages:

1. Punches only those locations needed in the program. Any seven consecutive minus zero locations are bypassed.
2. Requires only the user's read-in location on the drum for writing the drum on tape. Therefore, all locations other than the user's read-in and punch areas can contain instructions.

SET DRUM TO MINUS ZEROS -- 1.6.002

Sets all drum locations except 0000 and 0001 to minus zeros.

SET DRUM TO STOP CODES -- 1.6.003

Sets each drum location except 0001 to -01 xxxx 8000 where xxxx is the address of the location.

CLEAR BLOCK TO ZERO -- 1.6.006

Clears a specified block of storage to zero.

FIVE-PER-CARD CONDENSING ROUTINE -- 1.6.007

Condenses a one-word-per-card deck to a five-word-per-card deck and places a loading routine, file number 1.2.003, ahead of the condensed deck.

ONE TO SEVEN CONVERTER-- 1.6.009

Converts single-word load cards to seven-per-card load cards which may be used with the seven-per-card loader, file number 1.2.002.

BLOCK TRANSFER -- 1.6.010

Transfers a block of n drum locations to another block of n drum locations.

SEVEN TO ONE CONVERTER -- 1.6.011

Converts seven-per-card load cards to single instruction load cards.

A PROCEDURE FOR USING SOAP WITH A NUMERIC 650 -- 1.6.012

Enables SOAP to be used with a minimum 650 provided a 407 with summary punch is available.

FIXED TO FLOATING DECIMAL CONVERTER -- 1.6.013

Converts a fixed point number into a floating point number.

SOAP TO SEVEN -- 1.6.014

Will convert single instruction load cards to seven-per-card load cards. SOAP output cards may be converted immediately without removing special type cards. Only those locations from the FWA to the LWA are punched with the further provision that no output card shall begin with an unused location.

SOAP I TO SOAP II TRANSLATOR -- 1.6.016

Translates symbolic cards prepared for SOAP I into symbolic cards acceptable to SOAP II.

TABLE LOOK UP SUBROUTINE -- 1.6.018

This subroutine will linearly interpolate from tabulated values of a function and its argument.

INTERPRETIVE FLOATING DECIMAL ROUTINE -- 1.6.020

This routine is a modification of the Trimble interpretive floating decimal system described in IBM Technical Newsletter No. 8. It is designed for the 650 installation equipped with the automatic floating decimal device to provide a compromise between rewriting infrequently used programs which incorporate the Trimble routine and inefficient machine utilization while running such programs.

2.0.000 PROGRAMMING SYSTEMS

SIR: SOAP INTERPRETIVE ROUTINE -- 2.0.001

A relocatable library program which is used with the SOAP system to handle floating decimal interpretive operations.

COMPLEX ARITHMETIC INTERPRETIVE ROUTINE -- 2.0.003

Interprets and executes multiple address complex arithmetic instructions in addition to performing the normal 650 instructions.

ERCO SPACE SAVER -- 2.0.007

This routine is designed to save programming space by executing two instructions per line. The floating decimal point instructions are add, subtract, multiply, negative multiply, divide and add absolute as well as reset add, reset subtract, store and branch minus.

GENERAL PURPOSE SYSTEM FOR THE 650: L₂ -- 2.0.008

A general purpose three address floating point interpretive system designed to be easy to learn and use. The orders are not assigned definite locations so that program changes are very easy to make.

DOPSIR: DOUBLE PRECISION FLOATING POINT

SOAP INTERPRETIVE ROUTINE -- 2.0.010

DOPSIR is both a system of coding (uses a set of mnemonic operation codes in which all arithmetic operations are performed with double precision floating decimal numbers) and a relocatable library program, which interprets the said system.

FIASCO -- 2.0.011

Simulation routine which will simulate a 650 with indexing accumulators, floating decimal arithmetic, and high-speed (core) storage. This program is designed for use in checking out programs written for the augmented 650.

INTERNAL TRANSLATOR (IT) A COMPILER FOR THE 650 -- 2.1.001

Programs written as a sequence of statements in a general algebraic language (roughly similar to that of FORTRAN) are translated into programs in symbolic, i.e., SOAP I form.

3.0.000 MATHEMATICAL FUNCTIONS

SQUARE ROOT SUBROUTINE — 3.1.002

Computes the square root of a single-precision fixed-point number.

SINH A, COSH A, EXP A — 3.1.008

Calculates $\sinh A$, $\cosh A$, or e^A for a single-precision fixed-point number.

SIN-COS SUBROUTINE — 3.1.010

Calculates $\sin X$ or $\cos X$ for a single-precision fixed-point number.

ARC SIN A — 3.1.012

Computes arc $\sin A$ for a single-precision fixed-point number.

$\text{LOG}_{10} A$, $\text{Ln}_e A$ — 3.1.013

Computes $\log_{10} A$ or $\ln_e A$ for single-precision fixed-point numbers.

POLAR TO CARTESIAN COORDINATES — 3.1.015

Converts single-precision fixed-point polar coordinates to single-precision fixed-point cartesian coordinates.

SUM AND SUM OF SQUARES — 3.1.018

Computes the sums and the sums of the squares of N groups of K numbers.

FLOATING POINT e^A , 10^A , SINH A, COSH A — 3.1.020

Subroutine for e^A , 10^A , $\sinh A$ and $\cosh A$ utilizing the floating decimal arithmetic device and indexing register A. Maximum accuracy and range have been secured with reasonable running time and storage requirements.

Nth ROOT FIXED POINT SUBROUTINE — 3.1.024

Computes the N th root of a single precision fixed point argument A.

FRATS (Fast, Relocatable, Arithmetic and Transcendental Subroutines) — 3.1.026

Provides general utility routines for floating point calculation.

CIRCULAR AND HYPERBOLIC FUNCTIONS:

REGULAR BESSEL FUNCTIONS — 3.2.001

Computes $\sin x$, $\cos x$, $\sinh x$, $\cosh x$, $J_n(x)$, and $I_n(x)$ for $n = 0, 1, 2, \text{ or } 3$.

MATHIEU AND MODIFIED MATHIEU SUBROUTINE - 3.2.006
 Computes Mathieu and modified Mathieu Functions

using canonical forms $y'' + (a - 2q \cos 2u) y = 0$

$$y'' - (a - 2q \cosh 2u) y = 0$$

and solutions of the form $y = \sum_{r=0}^{\infty} A_{2r}^{2n} \cos 2r u$

$$y = \sum_{r=0}^{\infty} A_{2r}^{2n} \cosh 2r u$$

4.0.000 DIFFERENTIAL AND INTEGRAL EQUATIONS

SIMULTANEOUS FIRST ORDER DIFFERENTIAL EQUATIONS - 4.0.001

A fixed-point routine that solves a system of equations of the form:

$$y'_i = f_i(t_1, y_1, y_2, \dots, y_n) \quad (i = 1, 2, \dots, n)$$

with the given initial values

$$(y_i)_{t=0} = K_i \quad (i = 1, 2, \dots, n).$$

MULTIPLE NUMERICAL INTEGRATION - 4.0.002

This subroutine uses the floating-point interpretive system developed by Dr. V.M. Wolontis, Technical Newsletter No. 11, and performs up to a triple integration.

FOURIER SYNTHESIS - 4.0.003

Computes double sums of the form:

$$S(x, y) = \sum_k \left[\sum_h A(h, k) \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} (2\pi hx) \begin{Bmatrix} \sin \\ \cos \end{Bmatrix} (2\pi ky), \right.$$

where either trigonometric function may be the sine or the cosine.

LAPLACE TRANSFORMATION - 4.0.004

Solves linear differential equations by evaluating the Laplace Transform of the equation. Input is $X(S) = A(S) / B(S)$ which is obtained by taking the transform and solving for $X(S)$.

$$A(S) = \sum_{i=0}^n A_i S^i, \quad B(S) = \sum_{i=0}^m b_i S^i.$$

ELLIPTIC INTEGRALS - 4.0.006

Computes complete and incomplete elliptic integrals of the first and second kinds.

5.0.000 MATRIX PROGRAMS

MATRIX INVERSION - 5.1.001

Inverts matrices of 25th order or less.

SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS - 5.1.002

Solves b systems of n simultaneous linear equations with b righthand sides and a common coefficient matrix.

MATRIX-VECTOR MULTIPLICATION - 5.1.004

Multiplies a fixed-point, single-precision, square matrix M of order $n \leq 42$ by a vector X .

MATRIX INVERSION BY GAUSSIAN ELIMINATION - 5.2.002

Inverts a floating-point matrix of order n or solves b systems of simultaneous linear equations with b constant vectors and a common coefficient matrix of order n .

DOUBLE PRECISION MATRIX INVERSION - 5.2.004

Inverts a matrix and solves systems of simultaneous linear equations in double precision arithmetic.

COMPLEX AND REAL EIGENVALUES - 5.2.005

Determines real and complex eigenvalues for an $n \times n$ matrix A .

LATENT ROOTS AND VECTORS OF A MATRIX - 5.2.016

Calculates all the latent roots and vectors of a real but otherwise arbitrary matrix. All the latent roots and vectors are assumed real.

6.0.000 STATISTICAL PROGRAMS

MULTIPLE REGRESSION ANALYSIS - 6.0.001

Computes all components necessary for a complete regression and correlation analysis. There are four phases: (I) a logarithmic transformation of the initial data, V_i , to the form $x_i = \log V_i - C_i$ where C_i is an arbitrary constant or formation of new variables of the form $x_k = x_i x_j$; (II) Calculates means, standard deviations, and simple correlation coefficients; (III) part 1 computes the inverse of the matrix of simple correlation coefficients and part 2 computes partial correlation coefficients and multiple regression coefficients; (IV) computes the predicted values based on the regression equation or the residual between observed and computed dependent variable values.

CORRELATION COEFFICIENT ROUTINE - 6.0.003

Computes the means, standard deviations, and product moment correlation coefficients of $n \leq 50$ variables.

ANALYSIS OF VARIANCE PROGRAM - 6.0.004

Computes the sums of squares, with the exception of the high-order interaction term, necessary in an analysis of variance.

AUTO-CORRELATION PROGRAM - 6.0.005

Computes the values of the auto-correlation function for up to 1500 data elements, or the values of the cross-correlation function for up to 750 data elements in each time sequence.

MULTIPLE CORRELATION FOR 50 VARIABLES - 6.0.007

Obtains all possible correlations (1225) of 50 variables of 3 digits each.

POLLY: POLYNOMIAL FIT BY LEAST SQUARES - 6.0.010

Obtains a least squares fit of a polynomial

$$\sum_{i=0}^N a_i x^i$$

STANDARD ERROR OF REGRESSION COEFFICIENTS - 6.0.011

Computes the standard error of regression coefficients using as input the partial regression and correlation coefficients.

AUTOCORRELATION AND POWER SPECTRUM - 6.0.013

Autocorrelation and power spectrum.

CHI SQUARE AND PHI FOR 2 x 2 CONTINGENCY TABLE - 6.0.016

This routine computes Chi square and Phi for systems up to 100 observations and up to 70 one-digit variables.

A STATISTICAL INTERPRETIVE SYSTEM FOR THE IBM 650 MAGNETIC DRUM CALCULATOR - 6.0.017

A three address floating point statistical interpretive routine which is a modification of the interpretive routine by V.M. Wolontis described in IBM Technical Newsletter No. 11.

SURFACE FITTING - 6.0.019

Computes the least squares coefficients and the sums of the squares of the residuals for a power series in either one or two independent variables.

7.0.000 MATHEMATICAL ROUTINES

REAL AND COMPLEX ROOTS OF ALGEBRAIC EQUATIONS - 7.0.001

Computes real and complex roots of equations of the form

$$f(z) = A_0 z^n + A_1 z^{n-1} + \dots + A_n = 0$$

ROOTS OF A FUNCTION OF A REAL VARIABLE - 7.0.002

Locates the roots of an arbitrary function lying in a given interval and computes them to a specified precision.

8.0.000 PHYSICAL SCIENCES

OPTICAL RAY TRACING - 8.1.001

Determines the path of a beam of light as it passes through an optical system consisting of a number of different media with spherical boundaries.

ONE-SPACE-DIMENSIONAL MULTIGROUP - 8.2.003

Solves the one-space-dimension multigroup formulas.

BALL: A REACTOR CODE FOR SPHERICAL GEOMETRY - 8.2.016

Ball is a two-energy-group, two-region, time-independent reactor code. It obtains a closed solution for a critical reactor assembly of spherical geometry, and also computes the normal and adjoint fluxes.

9.0.000 ENGINEERING APPLICATIONS

SURVEY TRAVERSE WITH BALANCING - 9.2.003

Computes the original and balanced values of length, bearing, components of each closure, and the coordinates of each station from the field data of a closed traverse.

CUT AND FILL - 9.2.004

Computes slope stake intercepts, cut, fill, and net volumes, adjusted, and accumulated volumes.

MOMENT DISTRIBUTION - 9.2.009

Computes final end moments in beams and in column tops of continuous beams built integrally with columns when distribution coefficients, carry-over factors and fixed-end moments are given.

FORECASTING ZONAL TRAFFIC VOLUMES - 9.2.011

Computes future zone-to-zone traffic movements given the present zone-to-zone movement and the estimated growth factors for each zone, using a method of successive approximations.

CURVED BRIDGE PROGRAM - 9.2.018

This program relieves the detailer of much of the laborious computation involved in the plan preparation of a curved bridge.

DETERMINATION OF COEFFICIENTS

FOR THE BENEDICT EQUATION OF STATE - 9.3.001

Determination of Coefficients for the Benedict Equation of State.

ELECTRICAL POWER SYSTEM TRANSIENT STABILITY CALCULATIONS - 9.4.001

It is possible to make the transient stability calculations for any system that can be represented by 19 equivalent machines or less. However, if the number of equivalent admittances required to represent the network does not exceed 200, a program limit of approximately 50 machines is possible (a 30 machine system has been studied). Induction machines as well as Synchronous machines can be handled.

PIPE STRESS ANALYSIS - 9.5.002

Computes the bending moment, torsional moment, bending stress, torsional stress, and the resulting combined stress at each end and the midpoint of every bend or elbow in a piping system. Also, the three moments and three forces acting at each anchor are computed.

WELL BORE DEVIATION RECORD - 9.6.001

Given the distances, bearings, and inclinations at various stations in a well bore, this routine computes the well bore deviation record, the depth and horizontal components of the bottom hole, and the x, y, and z components and coordinates for each station.

EQUILIBRIUM FLASH CALCULATION - 9.6.003

Calculates isothermal equilibrium flash vaporizations where the feed composition and K values are specified.

10.0.000 MANAGEMENT SCIENCE

TRANSPORTATION PROBLEM - 10.1.003

Solves the transportation problem, i.e., given the requirements at m destinations, and amounts available at n origins, and the cost of shipment from any origin to any destination the program will determine the minimal mode of transportation of a homogeneous product.

LINEAR PROGRAMMING - 10.1.004

Solves a linear programming problem.

LINEAR DECISION RULE FOR PRODUCTION AND EMPLOYMENT SCHEDULING - 10.3.001

Calculates optimal linear rules for making decisions on aggregate production and employment utilizing quadratic cost functions.

11.0.000 DEMONSTRATION PROGRAMS

THREE DIMENSIONAL TICK-TACK-TOE - 11.0.002

This program is a demonstration routine for the IBM 650; it permits a human opponent to compete with the 650 in a three-dimensional version of the children's game of tick-tack-toe, or crisscross. Plays are made by entering in the storage entry switches the coordinates of a cell in a cube of order 4 and depressing the program start key; the machine will reply and stop, awaiting the opponent's next play.

12.0.000 UNCLASSIFIED

DEBUGGING PROGRAMS — 12.0.001

This paper describes a complete, automatic debugging procedure designed to provide the maximum amount of information about a malfunctioning program in the minimum amount of programmer and machine time. The following routines are used in the debugging procedure and complete information about them is given: Flow Tracer, Snapshot Tracer, Symbolic Seven-Per-Card Punch, all by S. Poley; Symbolic Tracing Routine by W.P. Heising and S. Poley; and Stop Codes by F.J. Chrinko.

The above routines, except the last one, are written in SOAP symbolic form, and are designed to be used by the SOAP programmer most effectively. The routines, however, can be used by the non-SOAP, or absolute, programmer, but a rudimentary knowledge of the SOAP system is necessary.

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